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THE BRICKBVILDER

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THE BRICKBUILDER.

AN ILLUSTRATED MONTHLY DEVOTED TO THE ADVANCEMENT OF ARCHITECTURE IN MATERIALS OF CLAY.

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SOME LESSONS OF THE PITTSBURGH FIRE.

THE great value of the fire that occurred in Pittsburgh on the 3d of May as an object lesson to all who are interested in the reduction of fire losses in buildings has been attested by the extended notices and discussions that have appeared in the architectural and technical journals. Some of the technical journals sent special representatives to investigate it, who gave more or less correct accounts, according to the authorities they consulted. THE BRICKBUILDER was the only journal that sent an acknowledged expert in fire-proof construction to make an unprejudiced report on it, which appeared, fully illustrated, in the June number. It was the only report that correctly described and illustrated the several methods of construction used in the buildings. It was demonstrated that the two buildings most severely tested were fire-proofed with systems depending on the use of burned clay, and the material of each differed from that of the other. It was shown that the integrity of each building was assured by its fire-proof interior construction, and that the only parts carried down in one of them, involving a large and easily preventable loss, were destroyed through ignorance or carelessness in locating and supporting a huge water tank, and not through any failure of the fire-proofing system employed. Had this not occurred, there is no doubt but that all of the brick walls, and the steel work of the floors, roofs, ceilings, girders, and columns of both buildings would have been preserved. The value of fire-proofing with burned clay was demonstrated to the extent that while it might not in every case save itself, it can preserve from loss that which it is put to preserve.

This fire seems to have brought to the attention of underwriters, what is no surprise to any intelligent architect, the fact that if a building does not collapse the fire has a freer way through the goods contained in it. It is only a question of rates on goods with them, and does not concern us. If a building is undivided by partitions, they must necessarily put a higher rate on the goods; but the greatest demonstration has been made in the Jas. Horne Department Store, that, even though undivided by partitions, the building itself can stand the fire. They ought to be convinced of a matter in which some of them have doubts that fire-proof buildings, well constructed, can take care of themselves under all contingencies, and they now have some data for estimating what the greatest percentage of loss on such buildings can be. The Horne Office Building is one which best demonstrates the risk in the average of modern fire-proof building, and it had two dangerous elements, the exterior exposure and the open light court.

The first lesson to architects and owners, no less than to underwriters, is, that if you put a closed tank, in the form of a steel boiler, on the top of a building, even though it be placed there to furnish a supply of water to extinguish incipient fires, you are handling a very dangerous thing. The most improved systems for operating water elevators make it unnecessary to put a closed tank on the top of a building. Tanks in such places are necessary only where the automatic sprinkling system is used, and they can always be open tanks, built of wood, and supported so that they will tip over in case of fire and then do some good. There is no necessity for large tanks for ordinary water service, where pumps may be used constantly, or with automatic attachments. Another valuable precaution in fire-proof buildings, which has been used in some, would be to place a strong grill of steel over every elevator, sufficient to arrest the fall of the shieves and their supporting beams — which have to be exposed.

THE value of subdividing buildings by partitions needs no demonstration; but this can be done according to a system, and should be part of the original plan of the building. With a slight variation from what is considered the most convenient plan, any building can be provided with effective vertical fire barriers, and often buildings can be divided into sections without impairing the convenience of their plans. Forty years ago the printing house of Harper & Brothers, in New York, was built without an interior stairway or elevator, these being placed in towers in a court. There are two modern fire-proof buildings in this country which are built on a fire-proof plan. They are those of the American Bank Note Engraving Company, at New York, and Gore's Fire-proof Hotel, in Chicago. Both are built with a long court in the center, and with stairways and elevators so separated, being placed at both ends of the court, that they do not need fire escapes. In these buildings one half is the fire escape for the other half.

With regard to the details of fire-proofing with burned clay, we always have many things to learn as well as many reasons for congratulation in the present instance. Clay fire-proofing has to perform two offices; one is construction or work, and the other is protection. Protection is also sometimes combined with construction. Floors, ceilings, and roofs are constructions. It has been demonstrated that a flat, hollow arch, two cells deep, will support a floor and stop fire even when the bottom cell is broken. It has also been demonstrated that a beam covered by a one-cell hollow block will be protected

architects, is published in connection with the advertisement of the Harbison & Walker Company on page xxx.

On page 160 the Philadelphia & Boston Face Brick Company

TERRA-COTTA PANEL.
Executed by the New York Architectural Terra-Cotta Company.

illustrate another of their series of handsomely designed brick mantels.

WE have received the "National Electrical Code," printed by the National Board of Fire Underwriters, the preparation of which is the result of the united efforts of the various electrical, insurance, architectural, and allied interests which have, through a national conference composed of delegates from nine of the leading architectural, engineering, and insurance societies, presented these rules for adoption by the various governing boards throughout the country. The effort to systematize and regulate the constantly changing practise in regard to electrical wiring is highly commendable, and the results embodied in this code represent the state of the science at the present time. Probably no branch of building industry has expanded so extensively within the last few years as has electrical science, and the rapidity of its growth has repeatedly outdistanced the municipal regulations so that it has several times happened that what was considered first-class work at one time would not be tolerated three years later. The effort to have things right which is manifested by this code certainly deserves every encouragement.

ARCHITECTS' AND BUILDERS' DIRECTORIES.

WE have had sent to our table two recently published directories of architects and builders, one embracing the State of Connecticut, and published by the Record Publishing Company, of New Haven, Conn., and the other embracing the State of Wisconsin, and published by the Builders' and Traders' Exchange, of Milwaukee. This latter work is made especially interesting by the incorporation into its make-up of many pages devoted to the consideration of questions which arise in connection with the building business, such as Mechanics' Lien Laws, Rules and Conditions for Estimating Work, Hints to Contractors, Information for Masons, Laws relating to Buildings, Plumbing, Sewerage and Sanitary Laws, and other matter of value to architects, builders, and contractors, the whole work having been compiled by W. H. McElroy, Manager of the Exchange.

Brick versus Wood. I.

BY R. CLIPSTON STURGIS.

IN the following articles I propose to treat briefly, first, the advantages of brick over wood; second, the adaptability of brick to all circumstances of climate and all classes of buildings; and third, a consideration of the means for promoting the more general use of brick.

In this article, then, I will consider the durability, economy, and beauty of brick as compared with wood. For one who understands the possibilities of brickwork, it is difficult to see why it is so often passed over as a building material and wood chosen instead. It can be only ignorance which will lead to such a result. There seems to be a prevalent idea that brick is very well in the cities, where, indeed, one must use it, but that wood is the right and proper material for suburban or country houses.

This is, indeed, a natural position to be taken by a primitive people, or a people who are painfully and with labor settling a new country. With them the timber which surrounds them, and which must be cleared to permit tillage of the soil, does, indeed, present

ST. ALBAN'S ABBEY.

itself as the natural material of which to build. Such a people were we when this country was first settled, and as, perforce, we then built of wood, gradually we evolved from the new surroundings and the necessities of wood construction a style quite essentially our own — the classic of the Renaissance reproduced in wood.

But we were not a primitive people even then, and we do not now live in a primitive country; wood is no longer the natural material which comes first to hand. Neither our spruce nor our pine grows now at our door. Even for a country house in Berkshire, or Mt. Desert, the material for a wooden house will largely come from far.

The wooden colonial house of New England was beautiful in its own way, and was a natural and lovely outgrowth of necessity, but the brick colonial house is quite as beautiful in itself and much more in keeping with our life and civilization. The brick house

when the outside shell of that block falls off. It has been shown that a semi-porous tile, when used for a continuous flat arch ceiling, will not be flaked off on the bottom, but that it may if used around a beam, two sides being exposed. It has been shown that in hard, hollow blocks of many cells the exterior shell is likely to be broken under any circumstances. The advantage is with the semi-porous tile, but the disadvantage is with the shape required for the projection of beams. The whole demonstration is that the continuous ceiling is the safest, especially when semi-porous tiles are used. There are some kinds of porous terra-cotta that will stand any fire-and-water test; but there is a difference whether the material is hollow or solid. In many cases it is best to use it solid, depending on the non-conduction of the material itself.

THE covering of the heavy steel built-up girders of the Horne Department Store was effective, and yet it was not by any means put on in a workmanlike manner. Large flat tiles of hard fire-clay were cramped to the bottoms of the girder, with steel cramps, and the sides were covered by 4 in. partition blocks resting on the flange. Great risk was taken in leaving the cramps exposed. They must have been raised to a white heat, and could not have sustained much weight; but it seems that each was able to keep its tile in place, the weight being, probably, not more than 4 lbs. to each cramp. The best methods for covering girders heretofore used have been with U shaped blocks of porous terra-cotta, extending far enough below the girder to support a soffit tile. Such blocks are firmly held in place by the mortar with which they are filled in setting, and partition tiles built on them to cover the sides of the girders add to their stability.

There are, unfortunately, too many Z bar columns in other buildings covered as were those in the Horne Department Store. It cannot be said that these columns were fire-proofed at all; 2 in. hollow partitions were simply built around them, and left to themselves. This would have been a compliance with the building laws of any city that compels all columns to be covered with "fire-proof material," providing for "two air spaces of at least 1 in."; and it demonstrates how defective such laws are. The contingencies that surround iron columns in any building are many, and have been the subject of experiments and inventions of experts for twenty years; but there is surely one principle that should be observed in fire-proofing columns, and that is that the material should be *fastened to the steel column.*

The 4 in. semi-porous hollow partition tiles used in the Horne Office Building were effective wherever they were set, so that they could stand alone, but most of them were cracked because they were *built on wooden strips.* The tiles did not crack in the walls, and were only broken by their fall. In Plate 10, in the June BRICKBUILDER, is seen the result of using a wooden framework when the door is combined with hall partition sashwood. This could be avoided by using channel bar steel frames in such cases. These might be warpled somewhat, but would keep the partitions in place.

These criticisms are offered in good part, with the hope that they may be of some benefit to those concerned in the fire-proofing of buildings with burned clay. They show that the buildings in question are not the best that have been done. We have seen that buildings as a whole can be saved by fire-proofing; but the fire-proofer cannot only protect constructions of steel, but preserve his own work, if he studies and profits by experience. It is his interest to demonstrate that the saving from the loss by fire shall commence with his own materials and workmanship, and unquestionably this is possible with burned clay properly used. He has nothing to do with what comes after him, and is not expected to insure the goods placed in a building. He cannot always do as he wants to, and the architect may ask him to put his work where he knows it will not stay; but our architects can also profit by experience, and will not fail to heed the lessons of the hour. The model for a *fire-proof building* should be, as Mr. Reed says, a good stove that can be used many times, and not requiring a new lining every time that it is fired up.

THE report of S. Albert Reed, Ph. D., Manager of the Tariff Association of New York, on the Pittsburgh fire, published in *Engineering Record*, is a very interesting and truthful statement, full of valuable suggestions to underwriters that will doubtless be heeded. We may therefore expect to see in the near future such an adjustment of rates as will tend to exert a corrective influence upon some of the neglected details of fire-proof buildings. We are glad to see that Mr. Reed agrees with our expert in nearly every particular. He differs, however, in his theory of the direct cause of the falling of the water tank in the Horne Department Store. He gives great stress to the fact that the roof beams supporting the ⊥ irons and book tiles were not fire-proofed, and that the upper ends of the Z bar columns of the sixth story passing through the blind attic were not covered with tile. This was undoubtedly a case of neglect, yet the blind attic was cut off by tile bulkheads around the skylight. He thinks that these fell out, and that the weakness of the roof let down the tank, the roof falling first. This supposes that the tank rested on the roof, which no ordinary constructor would allow. As the roof did not fall around the light shaft where the tile bulkhead fell out, it must be presumed that the bulkheads of the elevators and light shaft were dislodged by the shock of the tank falling through the roof. The suspended ceiling proved to be sufficient to stop the fire everywhere else and saved three fifths of the roof. Hence it would have been a barrier to protect all the uncovered steel under the roof if the tank had not fallen. It was undoubtedly the fire that rushed out over the elevators and stairway that weakened the supports of the tank, whatever they were.

Mr. Reed has a higher opinion of the column and girder covering used than Mr. Wight. The following sentences from his report show its drift: —

"The skeleton as it stands is not out of line or plumb. Except for the fatal omission of protection to roof supports the skeleton protection of this building was an unusually good piece of work, and it did its task successfully and well, mainly because it was good and thorough. It is important to state that such good column and girder protection is the exception in the Metropolitan District of New York."

"The question of skeleton protection I consider as settled by this fire. With good protection the skeleton may absolutely be relied upon to stand even a conflagration."

ILLUSTRATED ADVERTISEMENTS.

IN the advertisement of Fiske, Homes & Co., page vii, is illustrated a new design for a fireplace mantel by J. A. Schweinfurth, architect. This company has recently had prepared, by several well-known architects, a series of designs for fireplace mantels in brick and terra-cotta, that are of unusual merit in the matter of design and construction, and it is their purpose to show a different style in each issue of THE BRICKBUILDER.

In the advertisement of R. Guastavino, page xvi, is shown a view of the test recently conducted under the supervision of the Engineering Department, city of Boston, of a section of Guastavino floor in the new building at 270 Congress Street, Boston.

The terra-cotta entrance to the Union Trust Building, St. Louis, Louis H. Sullivan, architect, is shown in the advertisement of the Winkle Terra-Cotta Company, page xi.

A very decorative terra-cotta capital, designed by Hoppin & Kohen, architects, is illustrated in the advertisement of the New Jersey Terra-Cotta Company, page viii.

In the advertisement of the Bolles Sliding and Revolving Sash Company, page xl, is illustrated the new American Baptist Publishing Building at Philadelphia, Penn., Hales & Ballinger, architects.

The new public school building at Dobbs Ferry, New York, C. Powell Karr, architect, is illustrated in the advertisement of Charles T. Harris, Lessee, Celadon Terra-Cotta Company, page xxviii.

A residence in brick and terra-cotta, by Green & Wicks,

to-day, as the wood in primitive times, is the fitting and proper house. It is more durable; it is — partly because of its durability — more economical, and admits of a wider range in things beautiful, because a permanent material has in itself elements of beauty which a perishable material can never have.

BROWN & DURRELL BUILDING, BOSTON.
Winslow & Wetherell, Architects.

For the three reasons of durability, economy, and beauty, we should certainly think twice when we are planning to build before we accept wood as the best material for our house.

First, brick is more durable than wood. It will stand dampness; it will stand heat. A brick, although more or less porous, is not injured by being exposed to damp. Even the severe test of alternate wet and freezing will not disintegrate brick (as it will many kinds of stone).

It is true that dampness must not be allowed to penetrate a wall to the inside, but precautions which will prevent this are so simple as to make the disadvantages of this hardly worth considering.

Nor is it subject to destruction by fire. It has come to perfection in the heat of the kiln, and is better adapted than any other material to stand the test of extreme heat and sudden cooling with water. Few stones will bear this. And if stone hardly bears comparison with brick on these two points, how much less does wood, which rots when exposed to damp and burns when exposed to fire. Wood will rot from damp; it will rot from lack of air. It will burn. It is not as good a non-conducting partition, even when in perfect preservation, as a vaulted brick wall. It has no permanency. Everything tends to wipe away from remembrance all memorials of an age of wood.

Where are all the fine old colonial houses of Boston, which once were its glory? Gone! Some to make way for modern buildings; more fallen in decay and in the lap of devouring flames. What an indescribable loss it is to us that so many of our buildings, historic now, and ever becoming more so, are so often mere frame buildings, subject to decay, an easy prey to fire. The pity of it! For we cannot help it now.

We may be thankful that the walls of Independence Hall, and of the Old State House of Massachusetts, and of Faneuil Hall, are of brick; and it would have been well to-day if the ornament and outside finish of those buildings had also been of imperishable material, instead of wood.

It is not, however, because men think wood especially durable that it is so often advocated. The general plea is economy. Now, a material which is perishable must be very cheap indeed if it is economical in the long run as compared with its more durable substitute. A suit of clothes which with three months' wear is faded and worn must be cheap indeed to be as economical as one which will wear as many years and yet hold its color and its texture.

In the case in point the wood building is not by any means sufficiently cheap to bear comparison with its durable brick counterpart. For the saving lies wholly in the outside walls, that is, those that are above grade. The foundations for an ordinary house, for example, would be the same in either case, and the cost of the outside walls is, after all, not such a very large portion of the total cost. The foundations, the inside carpentry, floors, stairs, doors, windows, and finish, the plastering and plumbing, are not affected by the material of the outside walls, and the painting and heating, if affected at all, are in the direction of a reduction for the brick-walled house. It is on the walls only that the cost comes, and on these it might make a difference of eighteen or twenty dollars for every hundred square feet of wall. One can easily calculate what this would amount to on any given house. On one of tolerable size and cost it would probably be not more than five per cent. of the total cost.

And as an offset to this, one has a yearly saving in repairs and insurance, — this on the hard cash side; and then the comfort — not to be reckoned in dollars and cents, but worth dollars and cents notwithstanding — of feeling that one is well housed in a house that will endure, that protects you from winter's cold and summer's sun — as the wood will not — and that will outlive your day and perchance cover your children's children, and yet again, their children. There is something in that not to be overlooked and yet difficult to reckon: that love for the old homestead which comes only through long years

HOUSES, BEDFORD PARK, LONDON.
R. N. Shaw, Architect.

of possession, which, in turn, breeds love for one's own town, for one's own State, for one's own country — the best and purest patriotism, which has its roots deep down in the home.

It remains only to show that brick is essentially more beautiful

PALAZZO COMUNALE, PIACENZA.

than wood, and then, I think, we shall have a fairly strong case for the brick house.

This is, of course, the hardest point to really prove; indeed, we might call it impossible of proof, for even those most competent to judge might differ. I will therefore only say why it seems to me that brick is a more beautiful building material than wood.

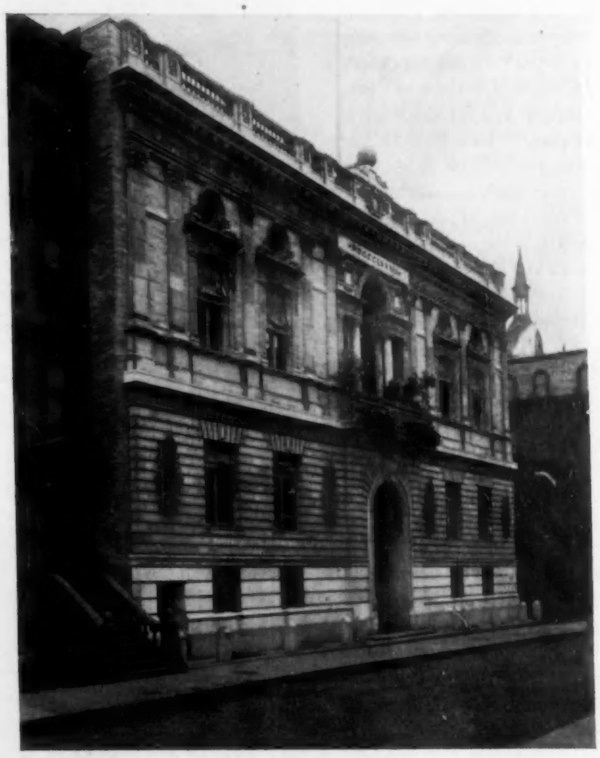
First, then, because after it has got the stamp from man's hand which shows it to be man's handiwork, and therefore fit and suitable for his needs, thereafter it is never touched again by aught but Nature's hand, which softens its rough or its too fine edges, covers it with bloom and beauty, and makes it year by year more lovely, until even in its decay and ruin (generally wrought by man) it is lovely yet. Look at the ruins of the Roman baths, Tattershall Castle, or that grand old tower of St. Albans. There are ruins which are beautiful, and good old stalwart brickwork, lovely in its age.

Now you cannot leave woodwork alone and yet have it preserve its usefulness. If left to weather and to be treated by Nature's hand, it does, indeed, become lovely. What more lovely in color and texture than a weather-stained board or shingle, or a water-washed or worn plank? But it is no longer fit for work. It is either not sound, or not tight, or not strong. No! we must protect our wood from the weather and keep it with oil or white lead, or else be constantly renewing it. Our house, then, always looks spic and span — nice enough in its way — or else shabby and disreputable.

It is the old story, our house is best when new; it doesn't improve with age; it must be constantly renewed to keep its value. But our brick house is worst when new, and grows yearly better and better. That is the kind of investment that I like, and that is one reason why I find it more beautiful.

The second reason is that it is a material which allows, and indeed demands, that its construction shall show. The wooden skeleton, the frame, is covered and protected, outside to keep out the weather, inside to cover its ugliness; but the brick-builder glories in his brick, and he finds in the necessary constructional bonding a chance for beautifying his wall, in his arches again an opportunity, in the vaults again another, and he need not be ashamed to show his brick wall inside. On this side of the case the constructional beauties of brick as a material might go on indefinitely. I trust I have said enough to at least set others thinking, even if I have not carried conviction.

As illustrations I would refer to Westover, in Virginia, a familiar but always lovely example of the best sort of colonial work. The tower of St. Albans (a sketch of which is given), dating back to 1200, now flanked by Gothic nave and nineteenth century additions which look almost trivial beside this massive old tower. The town hall of Piacenza, in brick and terra-cotta, and the apse of the church of the Frari in Venice, which has previously appeared in THE BRICKBUILDER, as examples of the ornate and the simple brickwork of Italy; and as similar contrasting examples in modern work, McKim's elaborate façade of the Century Club and Wetherell's quiet warehouse for Brown & Durrell, both excellent examples, and hard to beat in their way; and, finally, some very modest English work,



CENTURY CLUB, NEW YORK CITY.
McKim, Mead & White, Architects.

the lovely old Emanuel Hospital, at Westminster, now, I believe, swept away for modern improvements, and one of Norman Shaw's little houses in Bedford Park, a suburb of London, which owes nearly all its interest to what Shaw has done for it.

IT would be difficult to give stronger evidence of the intrinsic effect of a good colored material than is afforded by the fact that designs so really ignorant in their architectural detail as most of the buildings of the time of William III. and Queen Anne should, nevertheless, have a certain charm for us, solely derived from the beautiful color of the bricks with which they are built. — *Street.*

Architectural Terra-Cotta.

BY THOMAS CUSACK.

(*Continued.*)

THE advantage of jointing terra-cotta into reasonably large blocks received passing notice in the concluding paragraph of last article; but what constitutes a block of reasonable size is a question that was not, and, indeed, cannot be stated in the abstract. Within extreme limits, the size would depend upon its shape, the character of the work, and the situation it has to occupy when it reaches the building. One block contains, say, 240 cu. ins., another over 28 cu. ft., yet in both cases the size has been determined by the foregoing circumstances, without reference to the fact that one is but a two-hundredth part of the other, weighing 10 and 2,000 lbs. respectively. We have recently seen some excellent blocks of the latter size made and burned with complete success. These, we admit, were exceptionally large, but they served to prove what it is possible to do in this direction under favorable conditions as to shape, and in situations where large blocks are really necessary. Some manufacturers err in their indiscriminate advocacy of small blocks, forgetting that there are other things besides size to be considered. As it is always the poor workman who quarrels with his tools, so it is the poor terra-cotta maker who resorts to inordinately small blocks as a desperate remedy for ills that are otherwise, and at times, easily preventable. Degenerate types of the human family show a tendency to get back to barbarism, as an escape from the duties of advanced civilization. In a similar way do those who get behind in the well-contested race of architectural clay-working fall back upon less exacting forms, until they reach their level in the primitive simplicity of a brick. In the face of all that may be said to the contrary, we repeat that to joint work into needlessly small pieces is *not* the alpha and omega of architectural terra-cotta making.

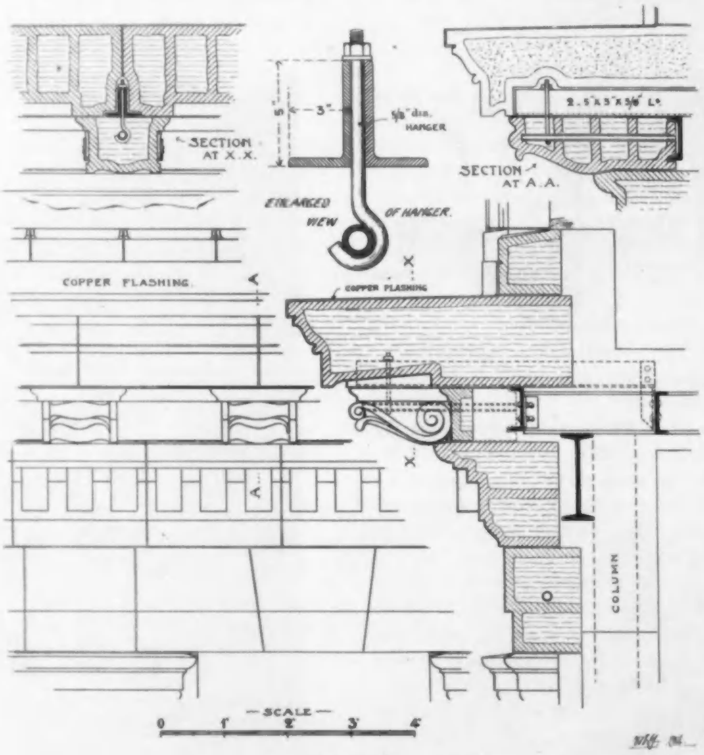


FIG. 26.

The actual size of a block in cubic inches has no meaning unless accompanied by the qualifying conditions that have just been referred to. Its relative proportions, and whether it could be molded on the widest dimension, as distinguished from the end or side, are among the technical things that an experienced terra-cotta maker would want to know before venturing an opinion. There is no formula by which even an approximate size may be fixed that would hold good in all cases. The nearest approach to one may, perhaps, be embodied in the following proposition. Let it be laid down as an abiding desideratum: First. That the block shall not crack in drying, and, having been burned at a high temperature, that it remains sound on all sides. Second. That its lines be practically true (they need not be mathematically so), its surfaces free from warping, and its shape as correct as the plaster model from which the mold was made. Third. That the maximum variation from exact size required shall not exceed one eighth of an inch in a block of, say, 3 ft., the same ratio being maintained in those of smaller dimensions. We would then say, let the rule be to make blocks *as large as practicable, subject to the foregoing conditions.*

It will be observed, however, that this rule is somewhat elastic for the size of our block, if not altogether an unknown, is, as yet, an extremely variable quantity. So it is, and so it must remain. Just what would be considered a practicable size might, in a measure, depend upon the color that had been selected, clays of different colors being more or less stable, and more or less tractable in their behavior. Account would likewise have to be taken of the plant and appliances to hand for drying and handling the blocks after they had been turned out of the mold. But these and other things being precisely equal, most of all would depend upon the skill, experience, forethought, and unceasing watchfulness of the man (or men) under whose direction the work is made. In like manner, but in a lesser degree, an important item towards success or failure must be charged to the account of care*ful* or care*less* handling. This would apply to every man through whose hands the blocks had to pass, from pressers to kiln setters. Thus does the actual result rest directly, and almost entirely, on an individual and distinctly personal basis. The form, finish, and degree of mechanical excellence in every block reflects the personnel of the men engaged in its production.

Let it be understood, once and for all, that in this department of terra-cotta making there is little, if any, room for automatic machinery. The only mechanism available for work of this kind is the head and hands — perchance the heart — of an individual man, or number of men. Not only does it represent the individual effort of mind and body acting upon matter, but every block of it becomes intensely human in all the excellencies or defects of its manipulation. As one man differs from another in intellect, training, and force of will, so does his work differ in accuracy, finish, and reliability. What is true of individuals is equally true of organized bodies; and the quality of their work in the aggregate will carry with it the indelible impress of their organization, as well as of their individuality. This is why the work of particular firms may be recognized in most cases by its unerring ear-marks. Whether viewed in a spirit of comparison or of contrast, the observant critic finds little difficulty in tracing its origin, or in forming a fairly accurate estimate of the men entrusted with the making of it.

Most of these observations apply to the making of terra-cotta in general; but some of them have a significant bearing on the matter now in hand, which has to do with the construction of heavy cornices. In work of this kind large blocks, though, perhaps, not always absolutely necessary, often become of vital importance. The extra size required is, in a measure, compensated by the nature of the situation; and it in turn makes the conditions of manufacture less exacting, therefore more favorable to the production of large pieces. The reasons why this is so were given with sufficient detail in connection with Figs. 23 and 24. But in Fig. 26, where we have

a cornice of much greater weight and projection to deal with, the same considerations hold good. The projection in this case is 3 ft. 6 ins., with 1 ft. inside the wall line. The modillions are spaced, some on 2 ft. 10 in., and some on 3 ft. 2 in., centers; and as the spacing determines the length of the pieces, their dimensions averaged 4 ft. 6 ins. by 3 ft. by 1 ft. 5½ ins., which is equal to 19 cu. ft., and would weigh about 1,200 lbs.

It may not be out of place to mention that these blocks were used on the new Astoria Hotel, 34th Street and Fifth Avenue, New York City (Fig. 27), where one hundred and fifty of them were required for the cornice at the twelfth story. Not one of these blocks being in any way defective when taken from the kiln, the original number was shipped, and set in the building without misadventure. For one of them see Fig. 28. Several mitres — some of them being both internal and external — of still greater size were made at the same time with equal success. Their dimensions were 5 ft. 1 in. by 3 ft. 11 ins. by 1 ft. 5½ ins., and the weight close upon a ton. Even with these, the limit as to size did not appear in sight, if we except the door into kiln, which was only large enough to receive them without any room to spare. These blocks, be it observed, conformed to the conditions just laid down as the governing factor; whether it be in the absence of cracks, trueness of line, or accuracy of shape.

FIG. 27. ASTORIA HOTEL, 34TH STREET AND FIFTH AVENUE, NEW YORK CITY.

H. J. Hardenbergh, Architect.

We now turn to the scheme of construction which, having been approved by the architect, and accepted by the engineers, was carried out exactly as shown in Fig. 26. The chief advantage in the use of two L's instead of an inverted tee is that it allows the hangers by which the modillions are secured to pass up between them. This furnishes a ready means of adjusting the modillions to line, by giving a few turns to the tension nut. The cantilevers so formed are thus made to act in a dual capacity; in suspending the weight of the work below, and supporting the much greater weight of that which rests on top of them. The strength of the modillions is greatly increased by the pipe — or, better still, bar of iron — that is passed through them before the chambers have been filled with concrete. The ends, being shaped to fit into the 8 in. continuous channel, makes them less dependent upon the hangers, which, however, it is well to have in case of accidents. This channel is bracketed to the outer end of floor beams, and acts as a fulcrum to the cantilevers, the ends of which are similarly secured to short pieces of channel introduced *between* the floor beams. The whole weight is in this way transmitted to the 16 in. I beam on which the floors rest, and it is really part of the structural framing between the columns.

FIG. 28.

We would call attention to the metal covering on the top surface, which we consider a wise precaution. It is not that a single block of this cornice really needs protection on its own account; unprotected it would certainly outlast the copper. The vulnerable point in all work of this kind is not necessarily inherent in the blocks, but in the joints between them. The mortar or cement is liable to wear out; and the repointing, which should be done every five years, is usually neglected altogether. This allows the water to gain access to the iron, and when that occurs, we fear it is then only a question of,— how long before it perishes?

BRICK PORCHES AND FENCES.

IT is remarkable what very ornate porches may be constructed by a judicious selection of brick. We have seen entrances to mansions built entirely of this material that far outweigh in grandeur and cheerfulness the ponderous stone columns that would appear to be indispensable to the building of many of our country mansions. In fact we have seen a red brick porch added to an old farmhouse built of stone, that, far from looking incongruous, was a decided attraction.

For fences there is nothing better than bricks. Pretty well any quality of brick can be used, and it is the only form of fence that age does not wither nor time decay. Where wood fences are used there is always the rotting of the foundations to contend with, and much necessary painting or tarring to be done to the superstructure. Architects do not sufficiently know what lasting walls can be made by cast-off bricks, and what added charm is given to a house when lichen and creeper have added their finishing touches.— *The British Brickbuilder.*

WITH this issue, the continuation of Choisy's "The Art of Building among the Romans" is resumed. This work will now be published in successive numbers until completion, requiring probably four.

The Art of Building among the Romans.

Translated from the French of AUGUSTE CHOISY by Arthur J. Dillon.

CHAPTER III.

CONSTRUCTION IN WOOD.

GENERAL REMARKS ON THE METHODS IN USE AMONG THE ROMANS.

(Continued.)

IN these modern works, the squared timbers are frequently superseded by round ones, and the cleats by withes or cords. This elementary method of fastening was also much used by the Romans; or, at least, this may be deduced from the text where Vitruvius describes how ceilings imitating vaults should be constructed by means of poles firmly bound with slender stalks of flexible wood; and this is also brought out in the description the same author gives of the construction of caissons used in laying concrete under water.[1]

Of ancient wooden bridges there are really but two examples; the bridge over the Danube, built by Trajan at the time of his expedition against the Dacians, and the bridge over the Rhine, built by Cæsar, to facilitate the incursions of the Roman armies into Germany.

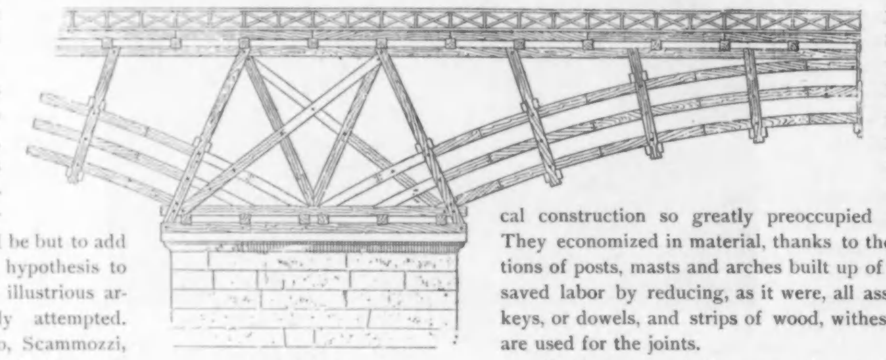


FIG. 95.

The bridge across the Rhine has been so often reconstructed, according to Cæsar's description, that to attempt still another restitution of it would be but to add one more disputable hypothesis to those which so many illustrious architects have vainly attempted. L. B. Alberti, Palladio, Scammozzi, have tried to interpret the text, and their efforts have only served to show the difficulties of the question; all agree that the platform rested on beams whose ends were fastened between two piles; but their agreement stops here. As soon as it is a question of the details of the structures, of that method of assemblage which, according to the expression of Cæsar, was strengthened by the effort of the current, one finds as many opinions as there are translators. It is sufficient to mention these numerous attempts; all seem very imperfect, but it is much easier to perceive their imperfections than to correct their errors.

As for the bridge over the Danube, the difficulties of its restoration are of an entirely different nature; for here it is a question of interpreting a strictly conventional view, which is almost as vague as the representations of the monuments in the landscapes of Pompeii, and which recalls only by a few characteristic traits the aspect of a Roman bridge.[2] Figure 95 gives the most important details shown on the bas-relief of Trajan's Column.[3]

[1] Caissons of beams fastened with withes (Vitr., Lib. V., cap. 12.).

Imitations of vaults made by means of curved panels of wood with ligatures, keys, and plastering (Vitr., Lib. VII., cap. 3. Cf. Pall., de re rust., Lib. I., cap. 13; Vitr. compend., cap. 21).

[2] Many critics have even thought, through faith in Dion Cassius (Epit., Lib. LXVIII., 13), that the bridge shown on Trajan's Column is in no way a representation of that over the Danube; the latter, according to them, was entirely of stone. But this is a question of no interest to us; it suffices that the bridge shown on the column is a Roman type of bridge. Nevertheless, we may note that in representing the Danube bridge to be of wood, the bas-relief agrees with an engraving of a medal in the National Library, where are to be seen the three distinct arches as well as the ties that bind them together; the medal shows these ties vertical, while in the bas-relief they converge, and this is the only noticeable difference between the two figures.

[3] The tinted parts in Fig. 95 are those shown in the bas-relief; the restorations are shown in outline only.

Three concentric arches form the active part of a truss; these arches are bound together by ties that extend up to the level of the platform, holding the string pieces and supporting the flooring. Above the piers, the platform is carried on trestles. Such is the bridge reduced to its essential parts. As to the accessory pieces, cross-braces or others, the maker of the bas-relief has left us in ignorance; this omission is permissible in a figure meant only to fix the place of an event; but it is to be regretted that it leaves so large a field open to conjecture. The arches, in the bas-relief, have no abutment, and it is difficult to understand the cross-bracing between the trestles; I have prolonged the arches to their meeting with the piers, and have considered the cross-brace between the trestles as continued to the level of the platform. These were, it seemed to me, the least changes that could be made in order to make the bas-relief of Trajan's column practicable; and everywhere else I have conformed to the model. The bas-relief leaves the question of the material of the arches entirely unanswered. It is clear, however, that these large pieces were built up of small beams; it can even be said that their construction recalls that of the corner posts of the towers of attack previously described. It was Apollodorus that described them, and it is Apollodorus who is thought to be the architect of the Bridge of Trajan.[4] But here positive evidence begins to become scarce, and to go into a more extended discussion would only lead to hypotheses which seem at the best useless.

These few examples, some borrowed from modern construction, will, I believe, help by analogy to a conception of the temporary framing, the scaffolding and centering whose economical construction so greatly preoccupied the Roman builders. They economized in material, thanks to their ingenious combinations of posts, masts and arches built up of small pieces, and they saved labor by reducing, as it were, all assembling to that where keys, or dowels, and strips of wood, withes and ligatures of rope are used for the joints.

Furthermore, whatever may have been the character of its applications, whether temporary or permanent, the art of framing was subject, to the same extent as the other branches of architecture, to the entirely local influences of resource and of traditions.[5]

Roman Egypt, as well as the Egypt of the Pharaohs, seems to have been devoted to the use, for building timber, of long stems, interlaced or held together by bonds of rushes (Strab., ed. Cas., p. 768 and 822).

Africa, at the time of Sallust, had an entirely distinct type of roofing, which recalled in appearance the hull of an overturned vessel, and which seemed the result of the effort to avoid the effects of the winds of the desert (Sall., Jug., cap. 18).

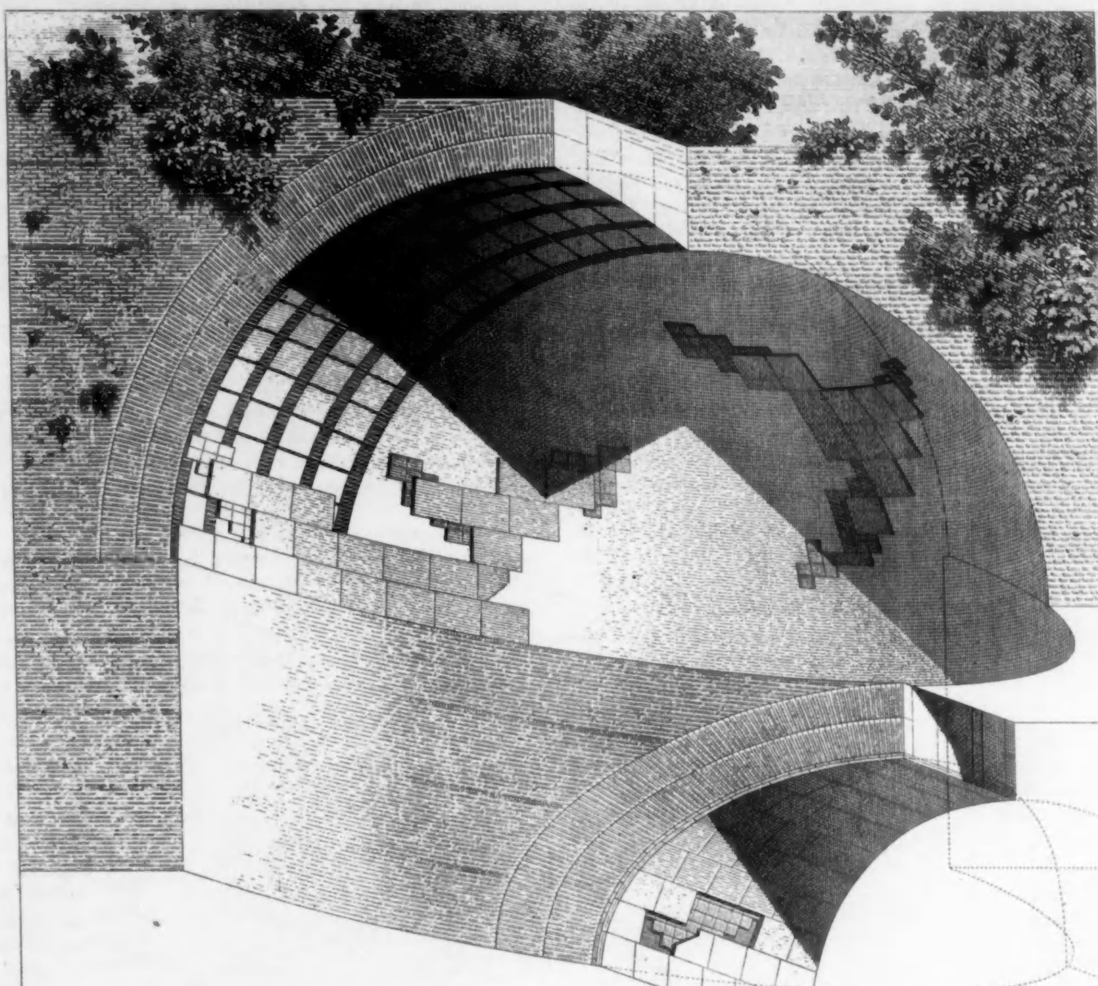
In Colchis, and without doubt in Arcadia, it was the use of round pieces, such as those used in the cottages in the Alps to-day, that regulated the entire system of framing (Pausan., Arcad., cap. 10; Vitr., Lib. II., cap. 1).

In Lycia the wooden buildings, made of panels interrupted at frequent intervals by strings of strong horizontal pieces, and covered by roofs of saplings, seemed to hold a middle place between the ordinary buildings and those with solid walls of horizontal trunks of Cholchis (see for the sculptures showing these constructions, the works of MM. Texier and Fellows).

In the Orient, at the extreme limits, or even beyond the frontiers, of the Empire, we find that the chief characteristic was the use of forked posts, from which came that type of the bifurcated columns that are so numerous in the ruins of Persepolis.

[4] Procop., de Adif., Lib. IV., cap. 6.

[5] I am indebted to M. Viollet-le-Duc for having called my attention to these local characteristics of ancient framing.



THERMES DE CARACALLA.
PLATE XII. THE ART OF BUILDING AMONG THE ROMANS.

Finally we come, in the midst of the forests that covered the soil of Gaul, or the country of the Marcomans or of the Dacians, to the masses of tree trunks, piled up in layers, sometimes mixed with rough or hewn stone, forming entrenchments, piers of bridges, fortifications on the banks of rivers—all that series of strange structures whose spirit is shown us in "Cæsar's Commentaries" and in the bas-reliefs on the columns of Trajan and of Antonius, and whose tradition has been preserved in Switzerland down even to the present time. I must limit myself, however, to the mention only of this variety of forms and methods, as well as of the double influence of local customs and natural resources which justifies it in our eyes, and which made it inevitable among the ancient peoples.

REVIEW OF THE METHODS OF ORGANIZATION OF BUILDING OPERATIONS.

We finish here the examination of the methods of Roman construction; we have studied them in turn in the monuments built of concrete, in those of cut stone, and, as far as possible, in those of wood; we have separated and presented individually each of the parts of an ancient edifice; it is now the time to bring these elements together, to show them put into practice, and to indicate, at least by one example, the spirit of organization that ruled the great enterprises of construction. The practical art of the ancients was not, in fact, a simple combination of methods united by a community of principles; along with and above individual methods, the Romans introduced certain ideas of sagacious discipline which stamped their great architectural enterprises with the mark of that order and regularity which their political genius gave to the whole administration of the Empire. In a word, the Roman art of building was a matter of organization, and it is under this new aspect that we must now consider it. The Coliseum seems the building whose analysis will throw the clearest light on the general principles, so we will describe it both in relation to the organization of the workyards and to the general progress of the work.

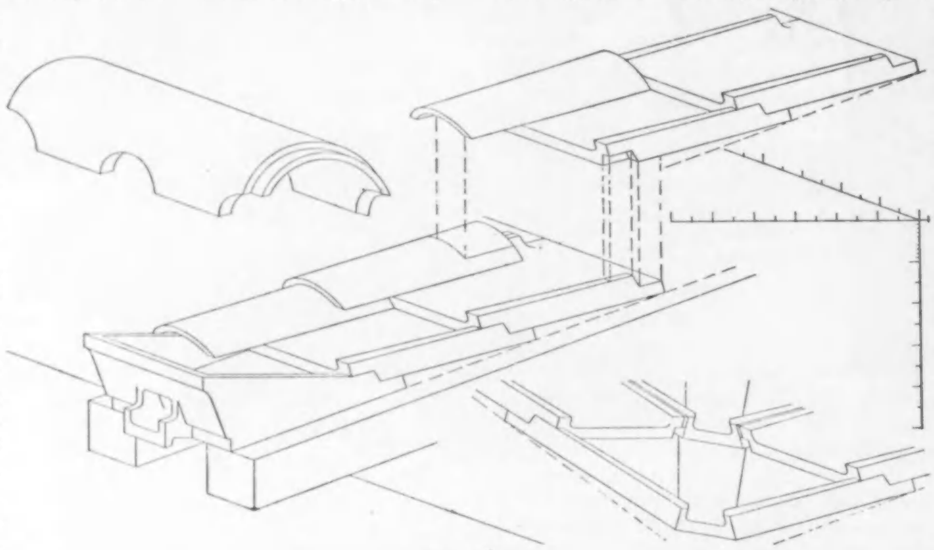


FIG. 96.

Plate XXII. gives a section along one of the radiating galleries of the Coliseum; the different tints show the different materials; the stones whose surface shows in a lighter tint against the more deeply colored background of the filling are blocks of travertine; the other stones are of a more common material, the compact volcanic tufa which, under the name of "peperin," is quarried at several points of the Roman Campagna.

The travertine is only employed, as can be seen, for the heads of the walls and for two intermediate piers — M and N — intended, without a doubt, to sustain heavy constructions, of which the idea was afterwards abandoned.

Without stopping to question what rôle the piers of travertine play, or were intended to play, in the edifice, we will note only their construction. Their courses bond, course for course, exactly with the courses of the filling. But this is not at all true for the heads of the walls, A and B. The courses of these pilaster-like heads run with the courses of the walls they terminate in the most incomplete, the most irregular, one might almost say, the most awkward manner. I show, in order to make the contrast more evident, the two cases of bonding; the first figure, Fig. 97, shows the imperfect bond between the heads and the walls; the other, Fig. 98, the regular bonding of the walls of tufa with the piers of travertine built in them.

At the first glance one is shocked by this so apparent incongruity; but closer examination finds in it an indication of one of those artifices of organization which the Romans introduced so happily into their great enterprises in order to simplify the progress and make it both surer and more orderly.

Evidently the disaccordance of the courses of the heads and the body of the wall cannot be justified by taking for its explanation only the difference of materials and the difficulty of quarrying the stone of Tivoli in blocks of the same height as the stone of Gabies or of Albano; the same difficulty would have existed in the bonding of the walls with piers such as M and N, which divided them. Yet, between the courses of the piers of travertine and of the walls of tufa, there can be seen (as we said above) none of those interruptions of continuity, none of those singular breaks; why then were they admitted, one might say purposely multiplied, in one case, and so carefully avoided and entirely proscribed in the other? The courses are not more regular in the heads than elsewhere, but their heights are different; only a few insignificant bond stones run into the filling of tufa; almost in every case these bonds cut the courses of the filling midway in their height, and chance only seems to have brought about the rare cases of accordance. Surely, the only hypothesis that can give a reason for these apparent anomalies is this — that the heads were built first of all; and afterwards the body of the walls, including the piers M and N, which strengthen it, was built.

This manner of proceeding is foreign to our customs, but its motives and advantages can be easily conceived. The pilasters A, B, C, once constructed about the entire perimeter, formed a sort of general plan in relief of the amphitheater whose utility can readily be perceived. We have here, in fact, an edifice whose plan is extremely complicated; the Coliseum comprised innumerable galleries and a great system of stairways and passages, hardly to be traced in the ruins, and much more difficult to distinguish in the midst of the disorder and confusion of the building operations. The builders were continually exposed to mistakes of all kinds when fixing the position and arrangement of so many diverse parts; and one can comprehend that the pilasters surmounted by arches, when built about the entire circumference, changing in form whenever the orientation or the shape of the stairways changed, would be of great assistance in limiting the field of errors and, as one might say, in rendering all doubt impossible in spite of the intermingling of the parts of the plan and of the multiplicity of its parts.

This separation of the work into distinct parts had another result not less important; it allowed it to be distributed among very distinct categories of workmen.

The pilasters A, B, C, and the arcades whose thrust they received, belonged to one class of workmen, to one series of operations;

the body of the walls to another; and in each the same operations were repeated without cessation. It was therefore possible to divide the workmen into two entirely distinct classes and to employ them according to their greater or less skilfulness or aptitude; it was, it may be said, an application of the ideas of modern industry on the division of labor. All the details, moreover, emphasize and explain this view.

In the lower story, the piers M and N bond with the filling; this because the piers and the filling differed only in the quality of the materials; the manner of building was the same, the care taken in the cutting was the same for both parts, and this entire portion of the edifice could be confided to the same workmen, hence a division such as that which existed between the walls and the heads had here no reason.

On the other hand, when the first floor level was reached, the cutting of the filling became less regular than that of the piers M and N. The courses of tufa were frequently interrupted; stones of all sizes were used and built in no regular determined order; here there was an occasion for a division of labor; and in fact, the bond between piers M and N and the filling was abandoned; the piers, up to this point cut with alternating long and short courses, suddenly became independent pillars, all of whose faces were vertical and continuous; the filling was butted up against these so that no bond whatever was obtained from the shape of the stones, as shown in Fig. 99.

If the architect thought this independence of parts justifiable when both piers and filling were built of cut stone, there was still greater justification for it when at the level of the second story he abandoned the use of cut stone in the filling and contented himself with rubble work with brick facing. Hence the piers of traverine — M and N—had in the entire height of the second story no bond with the walls; the faces of the piers were vertical, and the rubble was simply butted against them.

This example, moreover, is not the only one; the necessity of juxtaposing rubble walls and cut stone pilasters again arose in the parts of the radiating walls nearest to the arena; and in both cases there was the same solution of the same problem. The body of the wall at it slower parts, C–D, was of rubble with brick reveting; and here again all bonding between the walls and the cut stone pilasters terminating them was omitted. Instead of tieing into the rubble by alternate projecting and retreating courses, the sides of the pilasters were straight and smooth, and the different kinds of work joined, touched each other, but remained entirely independent.

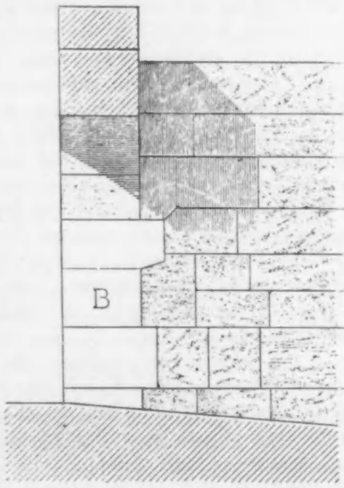


FIG. 97.

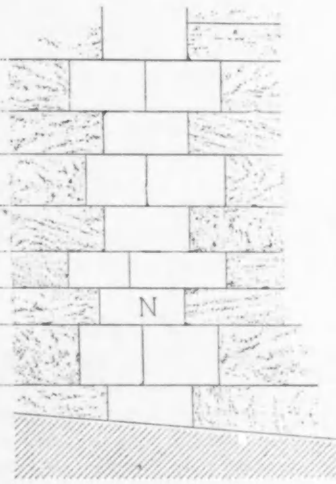


FIG. 98.

These were the principal expedients in the construction of the Coliseum. In general, one should notice the great variation in the sizes of the stones. Throughout the edifice there is an entire lack of uniformity; while, on the other hand, other Roman buildings show, in unexpected contrast, a regularity of cutting that is not less systematic and curious; such, for instance, as in the case of the voussoirs of the bridge of Gard. In fact, however, there is here no anomaly, and the two contradictory systems show less a divergence of method than the concession made to the difficulty of quarrying uniform blocks from such stone as travertine. Through principle the Romans sought uniformity of size in their materials; and they desired to obtain it not only in their construction in stone, but also in their framing, especially in rapidly constructed works. Thus (as above) all the timbers for an attacking tower were of the same scantling, and all were cut from pieces either 16 or 9 ft. long; to adopt such a system was to accept waste, be it in the forest or the quarry, but at the same time it was to become free from one embarrassment by removing the bond between the lumber yard and quarry and the carpenter shop and cutting shed.

This separation which we have just noted between the various parts of a building becomes manifest in a still more striking manner if we pass from construction to ornament.

In the buildings of cut stone, the builders nearly always left the stones roughed out, and other workmen afterwards cut the ornament on them. Sometimes moldings, because of their importance, had to be cut in place, and then they were cut on stones independent of the body of construction and separately executed. Thus the Romans were careful not to cut the very salient molding (Fig. 100), that runs like an archivolt about the opening, on the voussoirs themselves; and, following the example of the Etruscans, they gave it its own ring of stones and cut it after it was put in place.

The same independence existed, as we have seen, between the wooden framing and the ornaments which decorated it; these latter for the most part being carved or painted pieces nailed on the beams of the framing or in the panels of the carpenter work.

But it was above all in the concrete structures that the separation between the construction and the ornament was most manifest. The Roman built; others then took up the work and assumed the task of embellishing it. They applied stucco, reveted it with marble, covered it with ornamentation, more or less beautiful, but which was exacted by no necessity of the construction, nor even announced by its disposition; do away with this envelope and the first conception will still exist in its prime integrity, so independent is the ornament of its background, of the structure of the edifice it decorates. And this is not a theoretical distinction; the division existed to such a marked extent that often the applied decoration covers and dissimulates facings whose elegant arrangement becomes superfluous when their surfaces cease to be visible. It is not rare to see the Romans thus complete their tasks as builders without preoccupying themselves about the final appearance of the edifice, and lay the small stones of the rubble or the bricks with an evident care on the surface of walls, which the decorator, who came after, was to cover with slabs of marble or coatings of precious materials. As examples of this I reproduce (Plate XV., Figs. 3 and 4) some wall surfaces of arcades taken from monuments where they were to be concealed by thick veneering or revetting as soon as they were completed. The first example comes from the ancient tower of Autun, known as the Temple of Janus; the second from the Mausoleum of Augustus. One feels impelled to say, at the sight of these carefully built surfaces, in which the Romans themselves had no profit, that they feared the proximate ruin of the rich covering, and, desirous of leaving a souvenir to posterity, thought, perhaps, of the time when their works would appear as they show themselves now, deprived of all applied ornament.

But I would prefer to see in this care of the wall surfaces an expression of an entirely practical idea, that of allowing the diverse

corporations the greatest possible initiative; each thus had its part in the responsibility for the success of their common work, as each had its part in the choice of the means adopted. Each class of artisans remained, to a certain degree, the judge of the methods to be followed, and this privilege was used, as is known, by observing in the practice of the art certain traditional rules, which the organization of the workmen's corporations, perhaps somewhat narrow, made obligatory for all the individual members. The mason was not aware of what decoration would be applied to the walls; he constructed them according to certain admitted methods, and, whether they were to be covered by veneering or not, his methods were the same, the mass of the wall was built in the same manner, and the same care was given to the arrangement of the wall surfaces. Sometimes useless attention was given to work that was to be concealed by future decoration; but, on the whole, the uniformity introduced into the methods of work resulted in more rapid construction; and this was the main point in the eyes of the Roman architects. Under a social régime, when public monuments were often erected at the cost and by the orders of temporary magistrates,[1] rapidity was the first condition to be met, and the exigencies of decoration seemed hindrances from which it was useful to be free for the time being. Attention given to these matters during the preparation of the projects, and while carrying them out, would have involved inadmissible delay.

It is thus explainable why the Romans never accepted the system of construction of the Greeks except for temples, for façades of monuments or for buildings "*de luxe*," and of little importance. A system of architecture such as that of the Greeks, where the form is

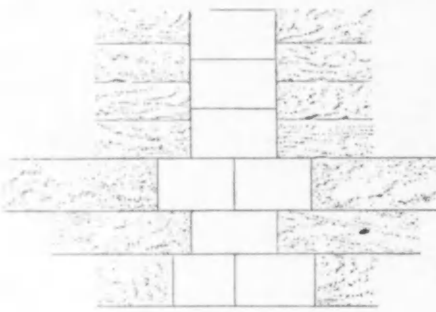


FIG. 99.

but the construction made visible, would have exacted an expenditure of time incompatible with the character and needs of the Romans. It was by separating the construction from the form, by putting aside questions of ornament at first in order to answer them later, that the Romans were able to maintain the order and simplicity necessary for the execution of their colossal enterprises.

In these days, when we build to meet imperious and pressing necessities, have we not some reason to imitate the ancients in this respect? And, moreover, we would not be the first to understand and follow this teaching of the Roman ruins. The architecture of the Italian Renaissance shows us continual and remarkable applications of it. The Roman idea of separating the decoration from the structure was never more in favor than in the sixteenth century in Italy. This can be seen, if need be, in the writings of that time (see, among others, Serlio, Liv. IV., p. 189, edit. of Venice). Still better, however, is it shown by the uncompleted edifices of that epoch, which are, for the greater part, rough masses of masonry, with recesses left for placing cornices and architraves, accessory ornamentaion which it was the custom to put in place afterwards. The architects of the Renaissance could have taken this practice directly from the ancients; bu there was no need of reviving the Roman tradition, for it had been followed in Italy, during all the middle ages; and the idea of sepa-

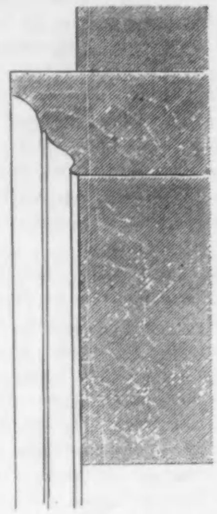


FIG. 100.

rating the decoration from the structure is perhaps the one idea that ties the Italian architecture of the middle ages most closely to that of antiquity, and which distinguishes it the most clearly from the contemporary architecture of France.

In France, during the middle ages, the structure and the form of the edifices were never treated separately; the stones always kept in the building, after they were set, the form given them in the stone yard; and it may be said that trimming and recutting in place were unknown in France from the twelfth to the fifteenth century.

On the contrary, in Italy during the same period, buildings were raised in masses of rude masonry, given, at the most, regular surfaces, where the architects afterwards incrusted the final ornament, or even placed entire façades. The façades of the cathedrals of Sienna, Orvieto, and Bologna are veneers thus placed, either over former façades or on walls prepared to receive a decorative revetment; and, without going to those celebrated edifices, it would perhaps be difficult to find a Gothic church in Pisa, Lucca, or even in the villages of Tuscany, where the decoration as a whole was done at the time of building. The enclosing walls of these buildings were sometimes built of rubble, with projecting bricks for ties, as can still be seen on the uncompleted façade of Bologna, by which were afterwards fastened the more or less richly ornamented outer walls. This reproduction of an ancient method in buildings whose general physiognomy resembles so little that of the Roman monuments affords one of the most curious examples of the variety of aspects that can be presented by the same idea, and of the apparent differences that can be manifested in the application of the same principle.

There are, however, few methods in the art of building that can be carried to their last expression with impunity. It is not for me to say what were the results produced by this separation on the architecture of the Italian Renaissance; but it must be acknowledged that this separation, so advantageous in rapidity and economy, had a regretable influence on the forms of ancient architecture. Becoming accustomed to consider decoration and structure separately, the Romans soon came to regard those things, between which they themselves had made the distinction, as being by their nature independent of each other; they then saw in the architecture of a building only a decorative dress, variable and in a certain degree arbitrary; the separation of the ornament and the construction gave too great freedom to fancy and to imitation, and contributed in precipitating the decadence of art among the Romans.

[1] This is clearly shown in numerous MSS. in the collections of Roman law. In particular see Cod. Theod., Lib. XV., tit. I., l. 19; Lib. VI., tit. IV., l. 13, 29, 30. Cod. Justin. Lib. VIII., tit. XII., l. 5.

I will add that a large number of public edifices were built by the magistrates "*pro ludis*," that is, in place of the festivals or games they were obliged to give to the people; thus the prodigality that was imposed on those who held public offices was turned to supplying useful work. But one can imagine what haste was necessary in erecting these magnificent presents when one thinks of the short term of office of the principal magistrates of the empire.

See Orelli, Inscrip., 3310, 2540 (?). Cod. Th., Lib. VI., tit. IV., l. 29.

Fire-proofing Department.

ORIGIN AND HISTORY OF HOLLOW TILE FIRE-PROOF FLOOR CONSTRUCTION.

BY PETER B. WIGHT.

(*Concluded.*)

FACTORS OF SAFETY.

NOTE.— The following article was written and in type before the Pittsburg fire occurred and the article commenting on the same was written, and the author sees no reason for changing any of the opinions herein expressed.— P. B. W.

THERE may be a difference in opinion as to what factor of safety should be used for hollow-tile work when it serves any constructive purpose. The manufacturers have not generally taken it into consideration, and *as there have never been any accidents in completed buildings, due to failure in the hollow-tile floor arches*, there does not seem to be any reason for anxiety about it. In Mr. Hill's comments on the tests, published in THE BRICKBUILDER for February, 1895, and in the reports of other engineers, it seems to be taken for granted that the factor of safety is one tenth. At that rate there is not a side-pressure or end-pressure arch in any building used for business or warehouse purposes that is theoretically safe if all the tests are correct. The actual tests of side-pressure arches of the best make have thus far shown that they break at from 500 to 1,000 lbs. per superficial foot, while those for end-pressure arches run up to about 1,700 lbs. I maintain that, if in a number of tests on similar side-pressure experimental arches it should be shown that none of them fail at less than 500 lbs. per foot, it would be perfectly safe to use them where the loads do not exceed 400 lbs. per foot. I know by experience that the average work set in buildings is stronger than the average work in experimental arches, for I have made frequent tests in buildings after construction to demonstrate this. I made not only tests for dead weight on flat arches covered with sand, but for rolling loads and smashing weights on the same, after laying the floors (the wooden floors bearing on the arches), as long ago as 1884, in the Chicago Board of Trade. The rolling load was with a 4,000 lb. safe, which was not only rolled, but dropped on one side several inches. The smashing test was made with cases of dry goods weighing 400 lbs. each, some of which were thrown down from a height of 6 ft. These were 9 in. arches with a span of about 4½ ft. They were not injured in the least, though the wooden floor was badly splintered and broken. In the Natural Gas Company's building at Pittsburgh, 9 in. side pressure arches made by the Wight Fire-proofing Company, set in the building, were tested by the architect up to 1,000 lbs. per superficial foot, and the tests stopped there as he was satisfied with the guarantee. It is, therefore, clear that no such factor of safety has been considered necessary by the makers, as suggested by Mr. Hill. Every contractor knows that the severest tests his work is likely to be subjected to are the accidental ones that occur during the erection of a building. The first test he makes himself when he draws his centering at the earliest possible moment, and it is thus that he insures himself against any carelessness of his workmen. He knows that if there are any defects in the work they will then be developed, and that if any tiles have not been well bedded, they will either fall out or be subjected to the natural pressure of the arch, while before the centering is struck they lie like inert pieces of material on the boards. He knows that every day adds to the strength of the work through the hardening of the mortar, and that this goes on indefinitely.

He often finds clauses in the specification saying that the centering must remain three days, five days, or a week, before it is struck, and his best judgment is often brought in conflict with the architect, whose intentions are all right, but for all that he may be mistaken. Then, when other mechanics are allowed to run over the work, pile up their material or throw down their scaffolding upon it, another set of inevitable tests begins and continues until the building is completed. I have seen enameled bricks piled up solid 6 ft. high on flat arches that did not fail, and no one to protest but the hollow-tile man. I have seen 9 in. side-pressure arches without any webs, covered with 1 in. of Portland cement and 2 ins. of planking, used as a runway through a building, for teams bringing in material, and with safety. These are the tests the contractor is impressed with. Then he has a common-sense idea of what an arch should carry, which does not seem to have been suggested to the engineers. He examines the iron diagram to see what is the strength of the steel floor. It is easy for him to ascertain what would be the weight per foot necessary to deflect the beams to a permanent set, and when he finds that his arches will bear this load he knows that his work will be the last to break when the floor goes down. Anything stronger than this is a superfluity, and when an architect specifies any kind of work between the beams that costs more than enough to accomplish this he is guilty of wasting his client's money. It is strange that this should have been so little considered. And here comes in the question whether or not anything is gained by using end-pressure arches where the side-pressure arch will accomplish all that is required, unless there is any economy in them. On the latter point it is claimed that there is an economy of weight in some sections of tiles when used for the deeper arches. Thus far there has been found no economy in making the walls of hollow tiles less than ½ in. thick, and this is only possible with the best clays. Therefore, the walls of end-pressure tiles cannot be made any less in weight or expense unless the section is so changed as to reduce the average weight per superficial foot. This, I think, has been done with the tile used by the Pioneer Fire-proof Construction Company, of Chicago, and Henry Maurer & Sons, of New York, for illustrations of which the reader can be referred to the advertising columns of THE BRICKBUILDER. But no advantage in weight is possible where rectangular tiles are used. One of the best end-pressure arches of this kind is that of the Terra-cotta Lumber Company, of Chicago, whose illustration is here given (Fig. 23). This arch is made entirely of porous terra-cotta.

Fig 23. Illinois Terra-Cotta Lumber Co's End Pressure Arch.

The skew-backs and the keys are set longitudinal with the beams The intermediate tiles are used on the end-pressure system. In such an arch the material of the skew-backs and key should be thicker than the intermediate tiles, to make up, if possible, for the want of cross webs. The bearing sides are partially inert. But this system shows a better method of setting the skew-backs and putting in the key than if all the tiles were set transversely to the beams. It is a type of all end-pressure arches in which tiles of rectangular section are used, and it is easy to understand from the illustration the variation from it when all the tiles used are on the end-pressure system.

OBSERVATIONS ON THE USE OF HOLLOW-TILE ARCHES.

The end-pressure system has not entirely supplanted the older side-pressure system. It has its advantages when the ultimate weight to be carried on the floors is greater than 400 lbs. per superficial foot. In this I agree with Mr. Hill, and in the main with his conclusions in his paper of July, 1896, which I have no occasion here to repeat. As long as the ratio of effective height to length of span is maintained within one to eight, it is only a question of economy as to which to use. I do not think that the superior strength of the

end-pressure arch is conducive to the reduction of the weight of floors for arches 10 ins. thick or less. Beyond this thickness, the weight of the end-pressure arch may be less than an effective side-pressure arch of the same depth. The cost of setting end-pressure arches is greater than for side-pressure arches.

The advantages of side-pressure arches are still maintained. First, by the greater ease with which they may be constructed, and the less chance of being weakened by inferior workmanship or defective tiles. Second, by the fact that there is a greater distribution of any concentrated load over a greater surface. Under the former may be comprised the more perfect bedding of the skew-back, and the possibility of driving in the key without losing the mortar, and under the latter may be mentioned the breaking of joints. In all side-pressure arches there is a considerable amount of inert material, but this is inevitable on account of the necessary process of manufacture.

The main defect in the end-pressure system is that the courses do not break joints. This has never yet been overcome, the only reliance being on the mortar joints and friction of surfaces, which depends upon the quality of mortar used. There is a way, however, to overcome this objection. Another is in the difficulty in making good joints between the voussoirs, involving always a great waste of mortar. The slight warping of the tiles in process of manufacture throws their abutting edges out of line, and on thin walled tiles this is of serious import. A much better joint can be had with porous than with hard tile, because the material is thicker, and for this reason the porous material is superior for end pressure arches. The greatest difficulty in getting a joint is at the key; for if it fits loose, the joint may run out before it sets, and if it is tight, the joint may be rubbed out in forcing it down. A good bed for a key can only be obtained by "slabbing" the ends of the interior voussoirs with thin pieces of tile before forcing down the key, having allowed for this in ordering the key. Another danger in arches where all the tiles are transverse to the beams is in the breaking off of the projecting bottom of the skew-back, or its cracking where it bears against the bottom flange of the beam; Mr. Hill's tests demonstrated this.

I agree with Mr. Hill that where the protection of the beam is by a projection from the skew-back on each side in any form of flat arch, it leads to defective construction and weakening of the arch. A separate soffit tile corrects this. My own form of soffit tile, which was the first ever used, passed around the flanges of the beam, and the skew-backs were bedded on this and the top of the flange and against web of the beam by one operation. (See Fig. 18, May BRICKBUILDER.) The abutting arches on both sides of the beam were also thrusting against the soffit tile. For this reason I have always maintained that in such constructions the effective depth of the arch was the whole depth of the tile, and this has always been borne out by comparisons between tests on experimental arches, where the soffit tile did not count for anything, and those set in buildings, which have always been in favor of the latter. In such cases two adjacent arches thrust against each other at the center of the soffit tile, the weight of the arch and floor being suspended from the lower flanges of the beam. I will therefore commend it to general use, as the invention is free for any one to use. Besides this, it has a greater advantage in setting. The soffit tiles are set dry on the centering, which when screwed up comes to a true line, while if the skew-backs run under the beams they are set before the centering is screwed up, and if screwed up before the mortar is hard, the bed of the tile on the beam flange is disturbed, and the arch is a defective one as soon as the centering is loosened.

A great improvement in the manufacture of hollow tiles was made after it became customary to make them in vertical sewer-pipe presses. This was first done for the Chicago and Western market, and soon after the example was followed by all the manufacturers in the Central States. Before this all the manufacturers in New Jersey used horizontal presses. The great advantage of the sewer-pipe press is its greater power, which by giving greater pressure to the wet clay makes it possible to reduce the walls, increase the strength, and consequently reduce the weight. This weight reduction was one of the first improvements that made it possible to erect high buildings on the compressible clay of Chicago, but has scarcely been recognized in the many treatises on high buildings that have appeared.

Notwithstanding many other ingenious and meritorious inventions for fire-resisting floor construction, many of which have the only merit of being incombustible, I believe that clay hollow-tile floor arches have come to stay for a long time yet, and that good burned clay will always be the best fire-proof building material. There will continue to be bad work of this kind, however, as long as architects are not discriminating in the quality of clay that enters into the material. Good concrete, which comes next in value, can only be used where bricks formerly were, and where the question of weight is not an important factor. There never will be any economy in using metal to reinforce tile construction, except to resist lateral thrusts, for the tiles can always do their work in compression. The only possible improvement I can see in floor construction with tiles may come when long tiles can be burned as cheaply as short ones, and can be used as lintels between beams. This was the dream of Mr. Scofield many years ago. I have always believed, and do so still, that in mechanics the flat hollow-tile arch with parallel top and bottom is nothing but a beam with confined ends, and that it makes little difference what direction the joints have, provided they are of good mortar and well compressed. There are very few scientific works that have given formulæ for constructions under these conditions. For the information of those who may be disposed to investigate farther, I will refer to a book entitled "Moseley's Mechanical Principles of Engineering and Architecture," with additions by D. H. Mahan, LL. D., published by the old firm of Wiley & Halsted, New York, 1856, pages 402 and 403.

With regard to the direction of the joints, I could never see any advantage in radial joints between voussoirs, which are so generally specified by architects, and which for that reason most manufacturers use. They complicate the work at every point from manufacture to setting, and increase the cost of the latter. In the Denver tests on side-pressure flat arches it is not generally known that as between two hard tile arches the one that broke at 651 lbs. per ft. had radial joints, and that which broke at 1,000 lbs. per ft. had parallel joints from skew-back to key. No record is made or comment given in Mr. Hill's reports of experiments, or, in fact, in any of the published tests, as to whether the arches were of one kind or another, but the illustrations show that the side-pressure tiles in Mr. Hill's tests had parallel joints.

An advantage of hollow tiles for floors which no other system seems likely to overcome is that at one operation it provides a ceiling and a floor, and in the shortest possible space of time. It is all dry in a few days, and does not hinder the rapid completion of the building and its delivery in good condition. It has another advantage in the fact that the arches can be made of any depth up to about 15 ins., and thus fill the whole space between the beams, reducing the concrete filling on top to a minimum, and thus reducing the weight of floors, and in some cases the cost of the work. For fire-proof qualities it requires no further commendation, though for this, as between good hard and good porous tile, I prefer the latter.

In this review of the condition of the art it is not intended to be implied that there are not other and meritorious systems of floor construction with burned clay that are of great value. The intention has been to confine the treatment of the subject to floor constructions in connection with steel beams. Already several systems have been in use which have greatly reduced the use of steel in fire-proof buildings, and they would be proper subjects for another treatise. But the present low price of steel has been such a strong argument for its continued use, that there does not seem any prospect of its ceasing to be the most favorable material to resist transverse strains for a long time to come.

Mortar and Concrete.

LIME, HYDRAULIC CEMENT, MORTAR, AND CONCRETE. IV.

BY CLIFFORD RICHARDSON.

CEMENT.

The word from which we have derived our name cement was originally applied only to certain additions which were made to lime mortar to enable it to harden under water, such as the puzzolana used by the Romans and trass. Later this designation was used for all the binding materials which furnished a mortar which hardens under water and so has extended to our natural and Portland cements. To avoid confusion all these materials are now classed as Hydraulic Agents, Hydraulic Limes, Slag Cements, Natural Cements, and Portland Cements.

HYDRAULIC AGENTS.

Hydraulic agents do not possess the property of setting or forming a mortar by themselves but they offer silica and clay to the lime of ordinary mortar in a form which permits combination between the two, and a slow hardening. They are of both natural and artificial origin. The natural form is from volcanic sources, such as the puzzolana of Italy, and the trass of the Rhine Valley. We have no such deposits available in this country except in the far West. The artificial form includes slags, burnt clay and shale, ashes, silicate of soda, and, in fact, any inorganic material which contains clay and silica in the form soluble in acids, that is to say, available for combination with lime in the presence of water. There is a plenty of such material in this country but it is rarely, if ever, used, owing to the cheapness of our natural cements.

HYDRAULIC LIME.

We have already seen that, as the amount of impurities of a clayey nature increase in ordinary quicklime, it takes on hydraulic properties. As long as this amount is not too large to permit slaking, although slowly, the lime is known as being hydraulic.

Hydraulic limes have had extensive use in England early in the century but have never been of the same importance here, although they were imported from France and England before the days of the development of our natural cements. When used they are not distinguished from poor quicklimes, and, of course, are never substituted for the true cements in hydraulic work.

Hydraulic limes with but a small proportion of silicates, 5 to 15 per cent., harden under water in from eight to twenty days, but with larger amount in from one to four. There is no very sharp line between poor cements and hydraulic limes. They usually contain less than 20 per cent. of silica and silicates.

Dolomitic limestones, when burnt at a temperature sufficiently low to expel the carbonic acid from the magnesian carbonate, but not from the lime, have hydraulic properties.

Slag cements will be considered in another chapter.

NATURAL HYDRAULIC CEMENT.

Toward the end of the eighteenth century it was discovered in England that certain limestones, when burned, gave a lime which would not slake, but, when ground and mixed with water, furnished a mortar which would harden under water. A similar cement was also prepared from the septaria or concretions found in the London clay. An examination showed that the limestones and septaria which furnished such cements would not dissolve entirely in acids but left behind a residue of clay. It was evident, therefore, that to the presence of the clay the resulting cement owed its hydraulic properties. Such cements were largely prepared and took the place of hydraulic agents and hydraulic limes, and from their resemblance, in color and results to the mortar prepared with the former, were called Roman cements, a name never used in this country where we hear only of natural cements.

EXTENT OF THE INDUSTRY. — The importance of natural hydraulic cement in the United States is attributable to the wide extent of the deposits of hydraulic limestone which are suitable for its manufacture. Such stone is found, to a greater or less degree, in a majority of the States, especially along the mountains of the Atlantic States, and is well scattered through the country lying along the Great Lakes and in the West. Cement works are found to-day in New York, Pennsylvania, Maryland, Virginia, West Virginia, Georgia, Ohio, Illinois, Indiana, Kentucky, Wisconsin, Minnesota, Kansas, Texas, Utah, and New Mexico. According to the United States Geological Survey there were 68 plants in 1895 producing 7,741,077 barrels of natural cement, worth about $3,895,424. More than half of this was made in New York; 3,939,727 barrels, and about 1,703,000 in the Louisville district, the next producers in quantity being Pennsylvania, Wisconsin, Illinois, and the Maryland and Virginia district with about 600,000, 476,000, 490,000, and 242,000 barrels. Ulster County, N. Y., where the well-known Rosendale brands are burned, and where the first natural cement in this country was made, alone put over three millions of barrels on the market in 1895, valued at half of the entire product of the year. The United States exceeds all other countries of the world in the quantity of natural cement which it manufactures.

HYDRAULIC LIMESTONES. — Natural cements can be made from limestones which have a very varied admixture of silica, clay, and magnesia, and considerable differences in physical properties. For each locality, where cement is manufactured, differences in composition will be found, as appears from the following analyses: —

COMPOSITION OF HYDRAULIC LIMESTONES USED FOR WELL-KNOWN BRANDS OF NATURAL CEMENTS.

ORIGINAL ANALYSES.

	1 New York Rosendale	2 New York Akron	3 Penn. Lehigh Valley	4 Penn. Roundtop	5 Maryland Antietam	6 Maryland Cumberland & Potomac	7 Illinois	8 Kansas Ft. Scott
Calcium Oxide CaO	25.80	19.93	29.94	35.76	23.72	25.54	32.85	35.00
Magnesium Oxide MgO	10.09	9.17	1.55	2.18	15.64	1.10	8.45	3.50
Carbonic Acid CO_2 and water . .	30.93	25.90	26.30	31.74	34.82	24.40	34.12	33.00
Silica SiO_2	21.41	33.80	27.77	19.81	15.97	25.72	17.01	21.80
Alumina Al_2O_3		3.96		7.35		12.28	3.35	3.70
	10.09		14.29		7.59			
Iron Oxide Fe_2O_3		.88		2.41		5.22	2.39	3.10
Sulphuric Acid SO_3	.66	.50	——	——	.71	1.53	1.81	——
Total Carbonates .	67.26	54.86	56.72	68.44	75.20	46.13	74.15	65.76
Insoluble in Acid .	29.21	35.01	40.15	27.25	20.15	47.72	22.06	23.95

	Carbonate of Lime	Carbonate of Magnesia	Total Carbonates	Alumina and Iron Oxides	Silica	Insoluble
Highest	63.75	32.84	75.20	17.50	33.80	47.72
Lowest	35.59	2.31	54.86	4.84	15.73	20.15

The most distinctive feature in the composition of hydraulic limestones, and one which enables them to be at once divided into two classes, is a marked difference in the amount of carbonate of magnesia which they contain. In the one class it is small, not exceeding 3 or 4 per cent; in the other from 15 to 35 per cent. is found. We have, therefore, two kinds of natural cements, lime and magnesian. With a few exceptions the hydraulic limestones of this country, used for making natural cement, are magnesian. In the Lehigh Valley the stone is not magnesian, and the same is the case in the upper Potomac Valley. Some of the deposits of the West are also nearly straight limestone. Considering their source the greater portion of natural cements, probably over 90 per cent., appear to be made from magnesian limestone. The rock from which the various Rosendale and Louisville cements are made, which alone make up a large part of our product, contains from 15 to 25 per cent. of magnesian carbonate.

The amount of the two carbonates in the limestones is very variable, reaching from 54 to 75 per cent. The silicates and silica may be present in larger or smaller amount, 20 to 47 per cent., and there are similar variations in the relation of silica to the bases, alumina and iron. In many cases there is much free silica with but a small amount of clay, as in the case of the limestone from Akron, N. Y.

The other and minor elements also show their peculiar but less important changes. In spite of these variations in composition natural cements are made from all these rocks.

Of course the properties of the resulting cements are very different.

Variation in the Composition of Rock in one Locality. — In addition to the variations in the composition of hydraulic limestone in different parts of the country a striking difference is also found in the strata in any one locality, or even in one quarry. There is generally no difficulty in distinguishing at a mere glance peculiarities of color and other physical properties which serve to mark the different strata and separate them. A chemical analysis is then required to determine the variations in composition or they may be tested by burning small amounts of the rock in an ordinary fire, crucible, or experimental kiln, or better, by both methods.

In case a chemical analysis is made it should be carried out according to the methods given in "Blair's Analyses of Iron and Steel," third edition.

In two cement rock quarries, one in Maryland and one in the West, strata are exposed which are typical of the variations in composition which have been mentioned.

COMPOSITION OF THE STRATA IN A WESTERN CEMENT QUARRY.

1. 4 ins. Limestone.
2. 6 ins. Limestone.
3. 20 ins. Bituminous shale.
4. 36 ins. Clay.
5. 48 ins. Cement rock.
6. 30 ins. Slate or shale.
7. 14 ins. Coal.
8. 30 ins. Clay, very hard.

	1	2	3	4	5	6	8
Loss on ignition. Carbonic acid, water and organic matter	40.2	43.0	32.90	7.2	33.0	6.50	6.3
Lime, CaO	48.0	50.1	.30	.5	35.0	6.70	.4
Magnesia, MgO	2.0	2.8	2.39	2.0	3.5	2.57	1.08
Alumina, Al_2O_3	1.0	1.1	17.00	19.1	3.7	13.00	13.6
Iron oxide, Fe_2O_3	1.8	1.0	3.90	4.4	3.1	3.30	2.4
Silica, SiO_2	6.7	2.6	36.30	61.8	21.8	65.60	72.9
Insoluble in acid	7.5	3.5			24.3		
Total carbonates	89.9	93.6			69.9		

COMPOSITION OF FIVE STRATA OF CEMENT ROCK IN A MARYLAND CEMENT QUARRY.

No. 1. Top. Not in use, below the slates and pure limestones.
No. 2. Cement rock.
No. 3. Not in use.
No. 4. Cement rock.
No. 5. Not in use.

	1	2	3	4	5
Loss on ignition. Carbonic acid, water, and organic matter	33.93	31.74	33.01	24.55	28.08
Lime, CaO	28.25	35.76	38.05	31.02	33.80
Magnesia, MgO	9.41	2.18	1.84	3.39	1.17
Alumina, Al_2O_3	5.25	7.33	5.58	4.17	5.43
Iron oxide, Fe_2O_3	7.07	2.41	3.88	8.29	2.40
Silica, SiO_2	15.71	19.81	16.7	26.52	24.62
Sulphuric acid, SO_3		.16		.19	
Insoluble in acid	28.13	29.66	26.05	29.10	33.51
Total carbonates	70.21	68.44	71.63	62.52	54.45
Magnesian carbonate	19.76	4.58	3.86	7.12	2.46

It appears that the strata of hydraulic limestone may be associated with others of purer limestone, of slate or shale, and in the West of clay and of coal. The presence of strata of slate and the purer forms of limestone are common to almost all cement rock quarries, whereas the clay and coal are peculiar to the geological formations of the West. The Maryland quarry illustrates how great the variations in composition may be in five well-defined strata, all of which are of hydraulic character. The upper bed in this quarry holds nearly 20 per cent. of magnesian carbonate, while the rest are comparatively free from it. The total carbonates vary from 54 to 71 per cent. and the silica and silicates from 26 to 33 per cent., with corresponding variations in the per cent. of lime present. In other quarries an even more striking variety of rock is found as will appear later.

There is also one other variation in the composition of hydraulic limestone which must be noticed. In the same stratum, as it is worked or quarried over a large area, differences in composition are found, due to changes in the material laid down at the time of its formation or, to a less degree, by subsequent action of water. Such variations must be guarded against, but they are usually of minor importance in a good quarry.

With deposits of such a diversified nature it is apparent that the manufacture of natural cement can be based on no absolutely uniform practise. For each quarry and each stratum its own peculiar methods of working must be found.

Character of Limestone Suitable for Natural Cement. — The different strata of hydraulic limestones in any quarry are not, therefore, equally suited for making natural cement. Their availability for this purpose has been determined primarily by experiment. By comparison of the results so obtained with the chemical composition of the rocks it has been shown that this is dependent on the amount of silica and silicates which they contain, or their relative proportions, and on the per cent. of magnesia, with some regard also to that of the sulphur compounds and alkalies present. It is also important that the silica should be combined with alumina, that any silica present should not be too coarse grained to unite with lime at the temperature of burning and that the rock should be of great density so that the burning and the product may both be satisfactory.

There are, of course, other substances in such limestones which are of minor or no importance, such as manganese, phosphoric acid, barium, which are present to the extent of but fractions of a per cent. The essential constituents, however, whose relations are to be considered as involving the suitability of the rock for cement making, are silica, silicates, including the alumina and iron oxide, of which they are composed, the carbonates of lime and magnesia and at times of iron, and the alkalies and sulphur compounds. These substances can be divided into those soluble and those insoluble in acids, the former including the carbonates and the latter the silica or sand and the silicates. In a rough way a determination of the relative proportion in which these two classes of substances are present is sufficient to characterize a hydraulic limestone.

A more careful inquiry into the effect of the presence of a larger or smaller amount of each constitutent is necessary, however, in order to understand thoroughly what properties the cement derived from different limestones may be expected to have.

The two great classes of natural cements, distinguished by the presence and absence of magnesia, have, to begin with, entirely different characteristics. The magnesian cements, of which the Rosendale brands are typical representatives, do not heat on mixing with water. They set and acquire strength slowly, but eventually are as strong as the lime cements. They do not resist the action of frost well when first used, and if not carefully proportioned have a tendency to expand a year or more after use. The lime cements, unless carefully made, have a tendency, when made into mortar on the one hand, to heat when too rich in lime and on the other to blow when too rich in silicates or when overburned. They acquire their strength rapidly, having nearly twice as great a tensile strength at from one to twenty-eight days as the magnesian cements. They resist frost better than the latter, but at the age of a year they are often not superior, in fact are, at times, inferior, more crystalline and brittle with a tendency to deteriorate in strength. The perfectly proportioned and carefully made cements of this class are, however, the best natural cements in the world. The Round Top cement of the Potomac Valley is typical of the highest grade of the lime cements, as the numerous Rosendale brands are of the magnesian class.

The Masons' Department.

STRAINS IN ARCHES. II.

BY JOSEPH MARSHALL.

IN all arches of the first class, and in arches of the varieties of the second class, shown by Figs. 5 and 7, there are three distinct forces in operation, but in all other varieties of the second class there are only two. These forces we will, for convenience, name "The Thrust," "The Counterthrust," and "The Counterfort," and under all circumstances, in all classes and varieties of arches, the counterthrust and counterfort, singly or combined, must equal the thrust before the arched structure can be in equilibrio. Of course all these forces are the result of gravitation on the mass of the arch, its load, and its supports.

The thrust is that force which tends to drive apart the supporting piers; the counterthrust is that which tends to draw them nearer, and the counterfort is that which balances the difference between the other two.

If the thrust and counterthrust were of equal intensity — a rare occurrence — then the counterfort were unnecessary. It is then of importance to determine quickly and accurately the relations between the efforts of thrust and counterthrust, and to this purpose we now address ourselves.

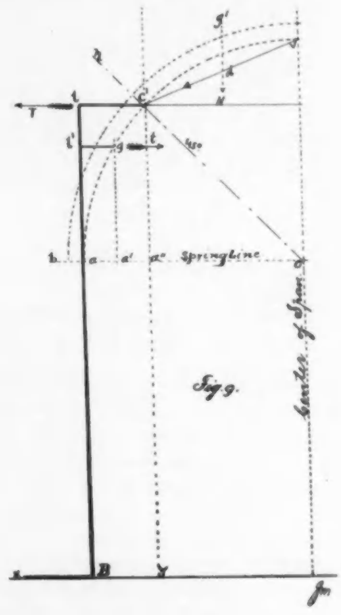
If thrust and counterthrust prevail in an arch — one opposing the other — at what point in the arch do the forces meet? For this must be a neutral point.

To this we answer: The neutral point will always be at the intersection of the arc of the arch by a line drawn at an angle of 45 degs. of elevation from the center, whence the arc is described, and this line and point we shall hereafter designate as the "Neutral" line or point.

It is evident that in a quadrant of a circle (which embraces 90 degs.) having one side parallel to the horizon, and the other perpendicular to it, the 45th deg. is midway between the vertical and horizontal, and that all parts below the 45th deg. stand more nearly vertical than horizontal, while all above that point are more nearly horizontal than vertical; hence, the weight of all parts below the neutral line will be discharged upon the piers with less tendency to disturb them than the weight of the parts above the neutral line, and moreover, the tendency to disturbance, which the arch below the neutral possesses, is exerted in the direction of the extension of that part of the arch, because in that direction it overhangs the gravity center of its support, thereby tending to draw with it in that direction the pier upon which it rests, while all that part of the arch above the neutral line, being suspended between the neutral and vertical lines, tends to force equally in both directions, but being opposed by an *equal* force on the opposite side of the vertical line (the force of the other half of the arch), its whole force is concentrated upon the neutral point, and being impelled by gravity, seeks the line of least resistance.

Referring now to Fig. 9, let us suppose that the vertical line from B to l possesses all the elements of a pier of brick 12 by 12 ins., except rigidity and sectional magnitude. Let the semi-circle in dotted lines from a to v represent the intrados boundary of an arch, the neutral line, $o\ n$ from o (the center whence the arc is described), will intersect it at c', which is the neutral point. We have then the weight of that part of the arch c' to v, and whatever load this may carry, as constituting the thrust and impinging at c'. By the resistance which the lower part offers, the direction of the force is changed to that of least resistance, which would be the horizontal — c' to l — as indicated by the arrow T. Then l to B will become a lever which will be acted on at l by the thrust force; and if this thrust force in pounds be multiplied by the length in feet of the lever $l\ B$, the sum will indicate the pound force at B if not opposed by any other force. This would be the case if we consider c' to v as constituting a *segment* arch, having a half span $o\ a''$ mounted on a pier, the inner line of which coincides with the line $c'\ Y$. But in the example in hand, we have the arch a to c' overhanging its pier from a to a'', and having the mean of its force above the center of its overhanging distance, as $g\ a'$, which tends to draw the pier in the direction of the arrow t. The pound force at g multiplied by the foot length of the lever $l'\ B$ will, in its sum, represent the counterthrust at B. We must here remember that the pound force at g will, in its efficiency, be one half the weight of the arch from a to c' and the load it bears. The counterthrust force at B will always be less than the thrust force for this form of arch and *all* others, except pointed arches above the equilateral, *i. e.*, pointed arches, the radius of which is *greater* than the span.

When the counterthrust is less than the thrust, subtract the less from the greater, and the difference will be the excess of the thrust force at B — supposed to be the base of the supporting pier. This excess must be counterpoised in some way by the counterfort. To do this, we must provide a gravity force conceived to be acting upon horizontal arms rigidly attached to the lever $l\ B$, so that it becomes a bent lever. This gravity force is derived from the weight of *all* of the half arch, the weight of the supporting pier, and more weight if necessary. We will then divide the weight of the half arch and pier — taken in pounds — into the excess of the thrust force in pounds, and the quotient will be the length in feet of the lever B to X which would be necessary if no more weight were added to the counterpoise. The lever arm B to x,



having the weight concentrated at the end B, then becomes the counterfort and balances the thrust — always assuming the pier is sufficiently rigid to sustain the load.

For the counterpoising gravity, then, we have: weight of arch, weight of pier, and weight of counterfort. It will be observed that it does not matter whether the counterpoising weight be placed on the lever $B\ x$ or the lever $l\ c'$, except that the lever $l\ c'$ is always limited by the arc of the arch, while the lever $B\ x$ is considered unlimited as to length; also, the lever arm $l\ c'$ will wholly disappear in arches of the second class, of the varieties shown by Figs. 6 and 8. In such arches, counterthrust is also absent. It is also evident that a part of the counterpoise may be applied to each of the lever arms $B\ x$ and $l\ c'$.

To test the foregoing reasonings as well as to better demonstrate the procedure, let us suppose Fig. 9 to be at a scale of ⅛ in. to the foot. It will then represent one half an arch 42 ft. span, mounted on piers 30 ft. to the spring. For convenience we will suppose the arch

and pier 1 ft. by 1 ft. sectional area, and weighing 120 lbs. to the cubic foot. Not pretending to extreme niceties, we measure the intrados of the arch *a* to *v* for length, and this we know to be 33 ft.; each lineal foot we will call a cubic foot. Now we know that there is 16½ cu. ft. above the neutral line, and 16½ cu. ft. below it. Then we have: —

Upper part of arch.		Lower part of arch.	
16½ cu. ft. × 120 lbs. =	1,980 lbs.	16½ cu. ft. × 120 lbs. =	1,980 lbs.
× lever *l B* in feet	44¾	÷ 2 (for half)	990
Thrust force at *B*	88,605 lbs.	× lever *l' B*	40¾
		Counterthrust at *B*	40,342

Hence, thrust	88,605 lbs.
Counterthrust	40,342 „
Excess thrust	48,263 „

This excess of thrust must be counterpoised, we will suppose, by the weight of the arch and pier, thus: —

Weight of arch	3,960 lbs.
„ „ pier	3,600 „

Excess of thrust lbs.

Total counterpoise w't. lbs. 7,560)48,263(6 ft.
45,360
2,903
× 12 for ins.
34,836(4½ ins.
30,240
$\frac{3,596}{7,560}$ about ½ in.

This would indicate that the lever arm from *B* to *x* would require to be 6 ft. 4½ ins. to just balance the forces of the arch if no more weight was anywhere added — the quality of rigidity in the lever arm *B x* being the agency through which the excess of thrust force is expended.

If the arm *B x* must be 6 ft. 4½ ins., what length must a similar lever be at the springing line of the arch? We have for that calculation the same weights for the two parts of the arch, but these weights operate through much shorter leverage. Then we have: —

Upper part of arch.		Lower part of arch.	
Weight	1,980 lbs.	Weight of arch	1,980 lbs.
× lever	14¾ ft.	÷ 2 (for half)	990
Thrust	29,205 lbs.	× lever	10¾
			10,642 lbs.

Excess of thrust 18,563 lbs.
÷ weight of half arch 3,960)15,840(4 ft.
2,723
12
32,676(8¼ ins.
31,680
$\frac{996}{3,960}$ = ¼

Thus, at the springing line we would require a pier (or lever arm) 4 ft. 8¼ ins. horizontal extension. This would seem to confirm our statement in the first chapter — that an arch could be overturned, even if the piers were absolutely immovable below the spring line; but the arches which may thus be destroyed are those only which exert a counterthrust, because it is only in this kind of arch that the thrust occurs above the springing line. Arches which have their springing line and point of thrust coincident upon their supporting piers may, indeed, fail, or be destroyed without final rupture of their piers, but only in a manner quite different from that pointed out above.

CRACKS IN TERRA-COTTA.

MANUFACTURERS of terra-cotta have a real grievance against builders and architects, on the score of the material not being properly dealt with by them. It would not be difficult to point to several large buildings in terra-cotta, the walls of which, especially in basements, are cracked from top to bottom. Speaking the other day to an architect who was very fond of terra-cotta, and had used it in many important buildings, we asked him why he did not now favor the material so much as formerly. His answer was not of the stereotyped kind relating to lateness of delivery and delays; but he indicated that he had been disappointed by the cracking of the material when subjected to much weight in heavy walls, though these cracks did not make their appearance until after the building had been up some time. No doubt many of the faults under such circumstances arise from settlement of the foundation; but we feel perfectly convinced that they would be far less prevalent and not be so noticeable if more attention were paid to setting and filling in building up the walls — and that is where the makers' chief grievance comes in. It seems to us that many of the large users regard terra-cotta for walls as a species of veneer; which does an injustice to the material. There are powerful reasons for not using terra-cotta in large solid blocks, on account of warping and twisting in burning and the like. And makers certainly have a right to insist on the filling being properly done, so as to render the blocks solid in the wall; it is not that the terra-cotta is at fault, but the builders. — *The British Brickbuilder.*

FRESH CEMENT, TO PAINT OVER.

A CONTRIBUTOR to *Painting and Decorating* recommends that the walls be washed with dilute sulphuric acid several days before painting. This will change the surplus caustic lime to sulphate of lime or gypsum. The acid should be about one half chamber acid and one half water, but if quick action is wanted 66 per cent. acid will answer. This should be repeated before painting, and a coat of raw linseed oil flowed on freely should be given for the first coat. While this cannot be always guaranteed as effectual for making the paint hold, it is the best method our correspondent has heard of for the purpose, and is worth trying when it is absolutely necessary to paint over fresh cement. — *Exchange.*

"POINTING."

AT this season of the year house fronts are commonly cleaned down, brickwork is "pointed," and with the assistance of paint the external aspect of the dwelling is changed. If people are silly enough to paint brickwork, let them do so; but there is more sense in "pointing it." What we desire to criticize in this "note" is the manner in which the pointing is done. The builder takes no trouble whatever over the bricks; he chips away the sharp, clean-cut edges, and scratches the mortar out. Then he fills up the holes made with mortar, and attempts to "restore" the sharp edges of the bricks by a compromise between a "trowel line" and a black streak. The chipped edges of the brick are hopelessly plastered over in the process, and never afterwards will the building front look like a good piece of brickwork. Whatever may be the excuses for pointing, — and they are many in populous, smoky districts, — there can be none for ruthlessly destroying the effect of a good piece of work. This morning we have just seen a really handsome brick front in process of mutilation in this fashion. The clipping and scraping having been duly carried out, a colored mortar — yellow, like the bricks — has been thrown in, and the clippings hidden by the leveling of the whole by the trowel. Then the inevitable "black streak" is performed, and the front looks as though it had been ruled into squares and irregular oblongs. And the "builder, decorator, and sanitary engineer" is so proud of his ghastly work that he has actually had the impudence to erect a board in the front garden giving his name and address! If "pointing" is to be done, let it be done carefully and reverently, and not as though the building were to form part of an ephemeral exhibition or raree-show. — *The British Brickbuilder.*

Recent Brick and Terra-Cotta Work in American Cities, and Manufacturers' Department.

NEW YORK.—The quiet season has begun in New York as well as in most of the large cities, as chronicled in the daily press. It seems inevitable, at this time of year, that there should be a dearth of large operations in building projects. The rush, not as powerful as usual, ceased about May 1, and speculators and investors are quietly resting now until time to search for "new worlds to conquer." Preliminary sketches are now in progress for several important buildings designed to be ready for occupancy in '98, but most of the activity this summer will be in the preparation of plans for small buildings and residences. Some of the most important items of news follow.

TERRA-COTTA FIGURE, 10 FT. HIGH, ON GABLE, AMERICAN BAPTIST PUBLISHING SOCIETY BUILDING, PHILADELPHIA, PA.
Frank Miles Day & Bro., Architects.
Executed by the Conkling-Armstrong Terra-Cotta Company.

The disastrous fire on Ellis Island, which fortunately was confined to destruction of property only, will necessitate the entire rebuilding of the island, which has been used for many years as the landing place and headquarters for emigrants from foreign countries. The buildings have always been considered unsafe and unsubstantial, and although frequent complaints had been made to the authorities at Washington, nothing was done, until now some action is inevitable. The President has suggested that an appropriation of $600,000 be made, and Col. John L. Smithmeyer, of Washington, has been appointed Superintendent of Construction for the erection of the proposed buildings. The new buildings will be fire-proof, of brick or iron, and so constructed that the several parts can be cut off from each other by fire walls and steel doors.

Clinton & Russell, architects, are preparing plans for a fifteen-story brick and stone office building, to be built at Nos. 35 to 39 Broadway, for the Hemenway estate.

Ernest Flagg, architect, is preparing plans for a building to be erected on the north side of 36th Street, near Broadway.

James B. Baker, architect, is preparing plans for an office building to be erected corner of Fifth Avenue and 45th Street, for T. T. Tower.

W. J. Dilthey, architect, has completed plans for "The Renwick" store and loft building, which will cost $100,000. It will be located corner of University Place and 10th Street, and will be eight stories, all fire-proof.

Harney & Purdy, architects, are making sketches for a Hospital and Home for Colored People, to be erected on Concord and Wales Avenues, and to cost $100,000. It will be a four-story brick and stone building.

Lamb & Rich, architects, are preparing plans for a Baptist Church to be built corner Convent Avenue and 145th Street. Cost, $75,000.

C. P. H. Gilbert, architect, has planned an hotel, to cost $200,-

TERRA-COTTA BELL TOWER, ST. JOHN'S CHURCH, JOHNSTOWN, PA.
Beezer Brothers, Architects.
Terra-cotta made by the Standard Terra-Cotta Company.

000, for the Imperial Realty Company. It will be a nine-story brick building.

CHICAGO.—Building news continues to be depressing. A late issue of the Chicago *Economist* gives a column headed "Desperation of the Architects," in which the condition of the profession is declared to be worse than the general results of business stagnation. The evils of cutting prices is alluded to, and particular stress is laid on the disastrous competition between architects and their own draughtsmen, who work at night and have no office expenses. We may hope that some of the evils of the illegitimate practise of architecture will be done away with as a result of the law passed lately by the Illinois legislature. Under the provisions of this statute, any one who desires to practise architecture must

TERRA-COTTA CAPITAL, STEWART BUILDING, CHICAGO.
D. H. Burnham & Co., Architects.
Executed by the Northwestern Terra-Cotta Company.

VANDERGRIFT RESIDENCE, PITTSBURGH, PA.
Alden & Harlow, Architects.
Bricks manufactured by Harbison & Walker.

pass an examination and pay twenty-five dollars for his license, and an annual fee thereafter of five dollars. Established architects are not required to take the examination. Every individual member of a firm must take out a license. Record must be made in every county where an architect practises. The bill seems to have passed with little change from the form in which it was recommended by the Institute of Architects. A casual reading gives the impression that the clause which allows a contractor to be his own architect may afford a means of evading the law just where, for the sake of good architecture, it ought to be most effective.

The make-up of the examining board, the conditions for revocation of licenses, etc., are details of interest to the profession, which looks at the bad business, worse architecture, and some of the so-called members of the profession who bring disgrace upon it, and *hopes* that the new law will accomplish something.

The most important item this month is a ten-story office building, by Holabird & Roche, which is to be erected this summer at Clark and Harrison Streets, to cost $200,000. This location is at present the south side limit of high office buildings.

N. S. Patton, architect for the Board of Education, has several schools on hand.

S. S. Beman is taking bids on a hotel to be built in South Bend, Ind.

Plans have been completed by H. L. Ottenheimer for a four-story apartment building, to cost $100,000.

Bishop & Colcord have a $75,000 building of the same character under way.

Robert S. Smith has designed two important apartment buildings.

Among good residences may be named one at $75,000, designed by Richard E. Schmidt. Architect Fritz Foltz is designing one to cost $25,000.

BUFFALO.—Last month ended with far brighter prospects for the building trade than have been seen for a long time. On every hand seems to be the opinion that, with the settlement of the tariff, this city will begin, if not to boom, at any rate to be very busy.

There are several large buildings to be started very soon, chief among which may be cited the new building for the Buffalo Savings Bank. It is to be erected on the corner of Main and Huron Streets. The site cost $260,000. The building is to be built from designs obtained in competition. A week ago the following architects were invited to submit sketches: C. W. Eidlitz and R. W. Gibson, of New York, and Green & Wicks, A. Essenwein, Lansing & Belerl, Geo. Cary, E. A. Kent, Beebe & Son, Bethune & Fuchs, and C. K. Porter, of this city.

The committee announced that $250 would be paid to each competitor, and reserves the right to reject any and all plans, or adopt any which meets with their approval.

The New York architects have notified the secretary that they will not enter on such terms, but have sent a circular issued by a number of architects whereby they agree to prepare plans under conditions not approved of by the bank authorities.

No reply has yet been made, but the prospects are that the local architects only will compete. The building is to cost $300,000, and is to compare favorably with any buildings in the neighborhood. The directors wish to obtain one of the handsomest individual banking houses in the county.

The former owner of the property has bought from the Catholic Institute a block on Main Street and intends to build a fine structure there. As a consequence of this, the Catholic Institute intends to go on with their Institute on the corner of Main and Virginia Streets, and Messrs. Metzger & Greenfield have received the order for plans for the same. The idea is to have a building about 60 ft. high, three stories, with a frontage on Main of 98 ft., and to be built in the style of Italian Renaissance, with an imposing façade. Terra-cotta is expected to enter largely into the composition of both these buildings.

A large apartment house is to be built on Franklin Street, near

CHAPEL, WASHINGTON STREET, BOSTON.
Rotch & Tilden, Architects.

TERRA-COTTA WINDOW LINTEL, OSTERWEIS BUILDING, NEW HAVEN, CONN.
Brunner & Tryon, Architects.
Executed by New Jersey Terra-Cotta Company.

Allen. The plans have been drawn out of town and everything has been conducted with great secrecy, but the fact has leaked out. It is to be an elaborate structure, and is to far exceed in finish and convenience any building of the kind erected so far in this city.

There has been some little excitement over letting the contract for fire-proofing the new school No. 12. One of the fire-proofing companies using hollow brick complains that the specifications have been drawn to suit the Expanded Metal Fire-proofing Company, thereby preventing any other class of fire-proofing from having an equal chance to bid on the work. Nothing has been done in this case, but a proposition has been made to allow all fire-proofing companies to submit estimates for the ironwork necessary for their individual systems.

TERRA-COTTA PANEL, BUILDING WAVERLY PLACE AND GREENE STREETS, NEW YORK CITY.
Robert Maynicke, Architect.
Executed by Excelsior Terra-Cotta Company.

PITTSBURGH. — Some few new buildings are maturing on paper, among which is a new school building for the third ward, Allegheny, for which Architect F. C. Sauer is preparing the plans. It is to cost about $200,000.

The North Braddock School Board have decided to erect a new school building at a cost of $20,000.

Architects Shaw & Bailey are preparing plans for a three-story brick schoolhouse for Warren, Penn., to cost about $30,000.

Architects Alden & Harlow have been selected to prepare plans for the new industrial school building for the second ward, Homestead, to be erected by Mr. C. M. Schwab, president of the Carnegie Steel Company. It will be two stories, of brick, and contain eight rooms, to cost $25,000.

The same architects have prepared plans for a four-story brick warehouse to be erected on Liberty Street, for John Way, Jr.

Local architects have entered competitive designs for a new library building to be erected by Washington and Jefferson College, at Washington, Penn., at a cost of $60,000.

The Fifth Avenue Baptist congregation have accepted plans for a new $10,000 church on the site of the old chapel.

Architect J. P. Brennan has prepared plans for an industrial school for the St. Paul's Orphan Asylum, Tannehill Street, to be three stories, of brick, and to cost $15,000.

A new Casino will be erected here from plans prepared by Architect J. D. Allen, of Philadelphia, Penn., of steel construction and terra-cotta, to cost $150,000.

TERRA-COTTA KEY, BUILDING WAVERLY PLACE AND GREENE STREET, NEW YORK CITY.
Robert Maynicke, Architect.
Executed by Excelsior Terra-Cotta Company.

ROCHESTER. — Thus far there has been but one important building erected this year — the new extension to the wholesale warehouse of Sibley, Lindsay & Curr, which is about 75 by 150 ft., seven stories high, iron and steel construction, terra-cotta partitions, and floor arches, and cost about $75,000.

The massive foundations for the new Lehigh Valley Railroad Company's new depot are as yet uncompleted. The latter building, when finished, will be one of the handsomest structures in the city, and is the work of Architect J. Foster Warner, as is also the Sibley Building extension.

Architect George T. Otis is about to let contracts for the erection of a four-story building for the Young Women's Christian Asso-

TERRA-COTTA PIER CAP, 15TH STORY, ST. JAMES BUILDING, NEW YORK CITY.
Bruce Price, Architect.
Executed by the Perth Amboy Terra-Cotta Company.

ciation. Building will be about 60 by 85 ft., with a gymnasium wing 30 by 75 ft.; the latter will be fire-proof. Front will be of press-brick, furnished by the New York Hydraulic Press-Brick Company, and trimmed with Indiana limestone, or Vermont marble and terra-cotta; the building complete will cost about $35,000.

The Rochester Steam Laundry Company are erecting a new press-brick front to their four-story building on Court Street, from designs by Fay & Dryer. New York Hydraulic Press-Brick Company furnish the brick, and Excelsior Terra-Cotta Company the terra-cotta.

Architects Kelly & Headley are about to let contracts for the erection of the Wayne County (New York) Court House, which they recently won in competition. Building will be of press-brick trimmed with light-colored stone and terra-cotta.

Architect Claude F. Bragdon, of this city, has taken in a partner, Mr. J. Con Hillman, of Portland, Ore. Messrs. Bragdon & Hillman have prepared plans for a number of buildings to be erected at Despatch, N. Y., ranging in cost from $1,500 cottages to the $30,000 hotel, including a town hall, church, and railway station, the latter being completed and the hotel started; all are of brick and in "colonial style."

BRICK AND TERRA-COTTA FIREPLACE MANTELS.

THERE are no materials which can be used in interior finish about the chimney corner to better effect than brick or terra-cotta, which, when skilfully chosen and arranged, produces soft, harmonious effects not obtainable in any other way.

Architects who have had large experience in the use of such material have learned, however, that the production of special designs is attended not only with such great cost as to be often prohibitive, but that the burning to order of special terra-cotta to the uniform color, size, and nicety required for interior decoration, particularly in the so-called "fire-flashed" colors, is a difficult undertaking, and results in frequent failures, delays, and disappointments.

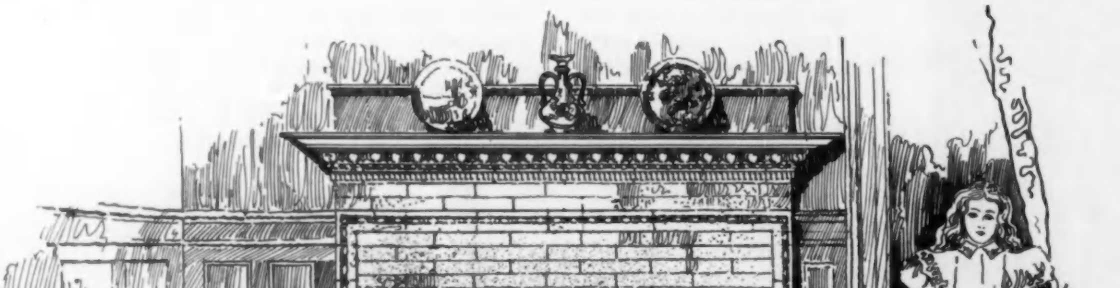
TERRA-COTTA FRIEZE, AMERICAN BAPTIST PUBLISHING SOCIETY BUILDING, PHILADELPHIA.
Frank Miles Day & Brother, Architects.
Executed by Conkling-Armstrong Terra-Cotta Company.

Any concern, therefore, that can offer a line of fireplaces in brick or terra-cotta, producing all the artistic effects of special designs, with the low cost and certainty of delivery attending stock patterns, will certainly make a most valuable contribution to the resources of our architects, and will greatly widen their present scope in the interior finishing of their buildings.

Fiske, Homes & Co., of Boston, have undertaken this task, and how well they have succeeded will be seen from the accompanying cut of one of their smaller designs, by the full-page advertisement shown elsewhere, and the series of drawings which they propose to illustrate in our pages during the coming year.

In their mantels they have adopted a somewhat novel method of handling the ornamentation, which is largely in terra-cotta form instead of molded bricks, thereby producing an artistic style not otherwise obtainable.

They have employed competent designers to first lay out the



BRICK AND TERRA-COTTA FIREPLACE MANTEL.
Designed by J. H. Ritchie. Del. by H. F. Briscoe. Modeled by Tito Conti.
Manufactured by Fiske, Homes & Co.

mantels without reference to the detail of the manufacture, giving them full scope to proportion and arrange them for the production of the finest architectural effects. The modeling has been done entirely by hand in the best classical style, while the pressing of stiff-tempered clay in smooth metal dies gives a nicety of finish much superior to the usual terra-cotta work made in plaster of Paris molds.

The terra-cotta work is all made in standard-sized interchangeable pieces.

In burning these pieces in the kilns, a variety of shades is obtained which are culled with great care, thus enabling an entire mantel to be furnished of a uniform color. This result cannot be accomplished in any other way, particularly in fire-flashed material.

A feature of great importance, which we hope will be appreciated and utilized by architects, is the opportunity afforded them of making designs to suit their own individual tastes as regards the choice and arrangement of ornamentation, by bringing together in any desired combination the standard interchangeable pieces which Fiske, Homes & Co. are now prepared to furnish. This method will give practically all the desirable features of special designs, but with the moderate cost and certainty of delivery already mentioned.

We illustrate above one of their low cost yet artistic designs in which the facing is made of 8 by 1½ in. bricks with beaded jambs, with a delicate bead and reel border, and the cornice of a skilfully modeled egg and dart and dentil design; a wood shelf and back-board are used to give a smooth and finished effect.

This design can be furnished in a variety of colors, and any width of opening from 28 to 48 ins. (varying by 4 in. intervals), the other dimensions being in proper proportion. By this flexibility of dimensions, which can be obtained only by the method adopted in these mantels, the requirements of any particular case can be suited.

OF INTEREST TO ARCHITECT AND MANUFACTURER.

Mr. J. Parker Fiske was admitted to the firm of Fiske, Homes & Co., Boston, on July 1, 1897.

Waldo Brothers have received the contract for furnishing the ornamental terra-cotta for Highland Spring Brewery, Boston.

Negotiations have been closed whereby Meeker, Carter, Booraem & Co. will, in the future, handle the Brooklyn business of O. D. Person, of New York.

Simpson Brothers, Boston, are using Alsen German Portland Cement for platform work at new Newton stations, buying of Waldo Brothers, New England agents.

The F. D. Cummer & Son Company, of Cleveland, Ohio, reports the sale of one of its celebrated dryers to be shipped to St. Petersburgh, Russia, and three to Antwerp, Belgium.

Waldo Brothers are supplying the Atlas brand of American Portland Cement for foundation work for Converse Building, Milk Street, and White Building, Boylston Street, Boston, Winslow & Wetherell, architects, and L. P. Soule & Son, builders.

The American Enameled Brick and Tile Company has closed contract with the board of trustees of the Ohio State University for about fifty thousand enameled brick for use in Townshend Hall Building, of Ohio State University, Columbus, Ohio.

Meeker, Carter, Booraem & Co., of New York City, have opened a branch office in the Arbuckle Building, Brooklyn. In addition to a full line of burnt clay materials of foreign and domestic manufacture, they will carry common bricks, lime, cement, etc. One of the principal reasons for opening this office is to push the sale of paving bricks, manufactured by the Eastern Paving Brick Company. This branch of their business will be in charge of Mr. Paul E. O'Brien.

The Tiffany Enameled Brick Company, Chicago, have closed the following contracts for their brick: Cataract Construction Company Power House, Niagara Falls, McKim, Mead & White, architects; Cook County Hospital, Chicago, Warren H. Milner, architect; Hecker Mausoleum, Detroit, McKim, Mead & White, architects; schoolhouse, No. 18, Buffalo, Aug. C. Esenwein, architect; stable for Mrs. Nearings, Toledo, Ohio, E. O. Falles, architect; Vocke Building, Napoleon, Ohio, E. O. Falles, architect.

The New Jersey Terra-cotta Company is making the terra-cotta for office building, 115 Wall Street, New York City, Jardine, Kent & Jardine, architects; office building, 830 Broadway, New York City, Cleverdon & Putzel, architects; High School, Concord, Mass., Chapman, Frazer & Blinn, architects; apartment houses, St. Nicholas Avenue, New York City, Henry Anderson, architect; apartment houses, 146–150 Eighth Avenue, New York City, Thomas R. Jackson, architect; apartment house, Monroe & Hamilton Streets, New York City, Louis F. Heinicke, architect.

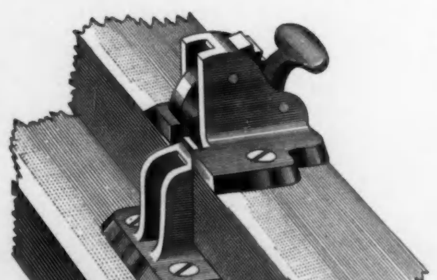
The Grueby Faience Company, 164 Devonshire Street, Boston, has been reorganized and incorporated under the laws of Massachusetts; W. H. Grueby, W. H. Graves, and Geo. P. Kendrick, directors.

Their reproductions of the old Moorish tiles in the dull, soft colors of the originals are attracting a good deal of attention, and Moorish designs and colors are already finding a place in modern baths and smoking rooms.

The brilliant effect of the Grueby faience in a plain white surface can best be seen in a recently completed station of the Boston Subway. This smooth, clean material cannot fail to find favor wherever cleanliness and the absence of the germ of disease is of prime necessity — in hospitals, laboratories, baths, schools, and all public works.

A pretty booklet has come to our notice illustrating the Pancoast ventilators, made by the Pancoast Ventilator Company, 316 Bourse Building, Philadelphia, Penn. It is invaluable for use in offices, sitting rooms, bedrooms, smoking rooms, railroad cars, street cars, churches, court rooms, schoolrooms, public halls, hospitals, etc. The advantages of the ventilator are, efficiency, neatness, durability, and perfection. This firm guarantees to exhaust as many cubic feet of air per minute as any other storm-proof ventilator made. The Pancoast building and chimney ventilators are said to be one of the best ventilators on the market, and are guaranteed to give entire satisfaction. They are made in all sizes of galvanized iron or copper. There are several testimonials contained in this book from people who have used these ventilators, and who praise them very highly. Write the manufacturers for a catalogue.

The Gale Automatic Safety Sash Lock, herewith illustrated, commends itself at once on inspection as being simple and durable (having no springs), and positive in its automatic locking of any window equipped with it on shutting the same, as the sash cannot be closed without the lock fastening the window. This lock does not interfere with the free movement of either sash, and cannot cut or mar the woodwork, even if carelessly used. The lock draws the sashes together in locking them, and will lock those, the meeting rails of which do not close within three eighths of an inch, just as securely as where the meeting rails are flush. If the upper or outside sash has dropped or sagged, the lock will force it up to the head of the frame, and when locked holds the sashes absolutely rigid, and



prevents rattling. A unique feature of the lock is that, in the event of one not closing the lower or inside sash entirely, the window is locked, as the lock fastens at three distinct points. The lifting of the lever or knob releases the lock, and the window unlocks as the sash is raised. For further information regarding this device parties may correspond with Rufus E. Eggleston, 576 Mutual Life Building, Philadelphia, Penn.

WE are in receipt of the following communication from Mr. T. W. Carmichael, inventor and manufacturer of the Carmichael Clay Steamer:—

I beg to call your attention to the great success of my clay steamer by handing you herewith a copy of a letter received from one of my latest customers. This party was in doubt about ever being able to make good pressed brick with his clay, but the steamer did not run longer than five minutes in his presence before he said he was satisfied.

GREEN BAY, WIS., May 22, 1897.

T. W. CARMICHAEL, ESQ., WELLSBURG, W. VA.

My dear Sir:—I am now satisfied our clay will make excellent Dry Press Brick. Your steamer has set us right, and I am now making press brick of the best quality.

If you want a recommendation, write out anything you want and I will sign it.

Respectfully yours,

THE WM. FINNEGAN BRICK COMPANY,

WM. FINNEGAN.

Remember, my steamer is sold on a guaranty. It is my machine until it does work properly. I make it a point to set or start the steamer myself, thus avoiding delay and experimenting. It can in most cases be set at night, so no time is lost.

The following are among my customers for this season:—

James McNeen, La Junta, Colorado.
The Washington Brick & Terra-Cotta Company, Washington, D. C.
Chisholm, Boyd & White Company, Chicago, Ill.
Alumina Shale Brick Company, Bradford, Penn.
Standard Brick Company, McKeesport, Penn.
Alumina Shale Brick Company, Bradford, Penn., second order.
Wm. Finnegan Brick Company, Green Bay, Wis.
Nicholls & Mathews, Wellsburg, W. Va.
Empire Press Brick Company, Denton, Texas.
N. W. Ballentyne, New Cumberland, W. Va.
Gladding, McBean Company, San Francisco, Cal.
Camden Clay Company, Spillman, W. Va.

My claim that "No dry press brick plant is complete without the Carmichael Clay Steamer" receives a practical endorsement in the above list.

TREASURY DEPARTMENT, Office Supervising Architect, Washington, D. C., July 8, 1897. SEALED PROPOSALS will be received at this office until 2 o'clock P. M. on the tenth day of August, 1897, and opened immediately thereafter, for all the labor and materials required for the erection and completion (except heating apparatus, vault doors, and tower clock), of the United States Post-Office, etc., building at Paterson, N. J., in accordance with the drawings and specification, copies of which may be had at this office or the office of the superintendent, at Paterson, N. J. Each bid must be accompanied by a certified check for a sum not less than two per cent. of the amount of the proposal. The right is reserved to reject any or all bids, and to waive any defect or informality in any bid, should it be deemed in the interest of the Government to do so. All proposals received after the time stated for opening will be returned to the bidders. CHAS. E. KEMPER, Acting Supervising Architect.

"BROOKLYN BRIDGE BRAND"

ROSENDALE HYDRAULIC **CEMENT.**

Warranted Superior to any Manufactured.

STRONGEST, DARKEST, UNIFORM, RELIABLE.

Over 100,000 Barrels used on NEW YORK AND BROOKLYN BRIDGE, AND 50,000 Barrels used on WASHINGTON BRIDGE, HARLEM RIVER.

Telephone Connection. WM. C. MORTON, Sec'y.

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IRON-CLAD PORTLAND CEMENT.

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A High-Grade American Portland Cement unsurpassed for making fine artificial stone.

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- Vulcanite "
- Gem "
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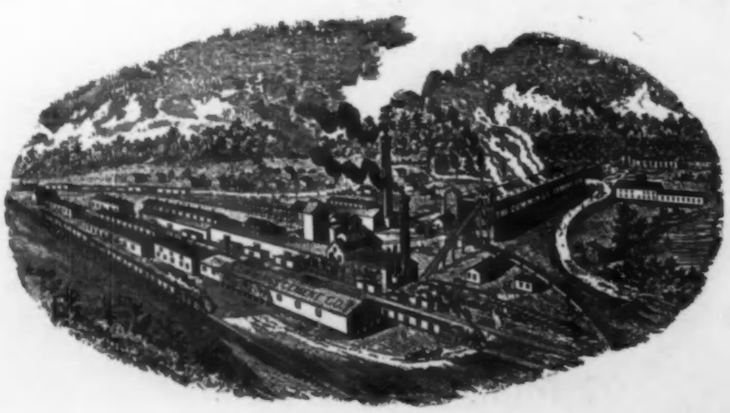

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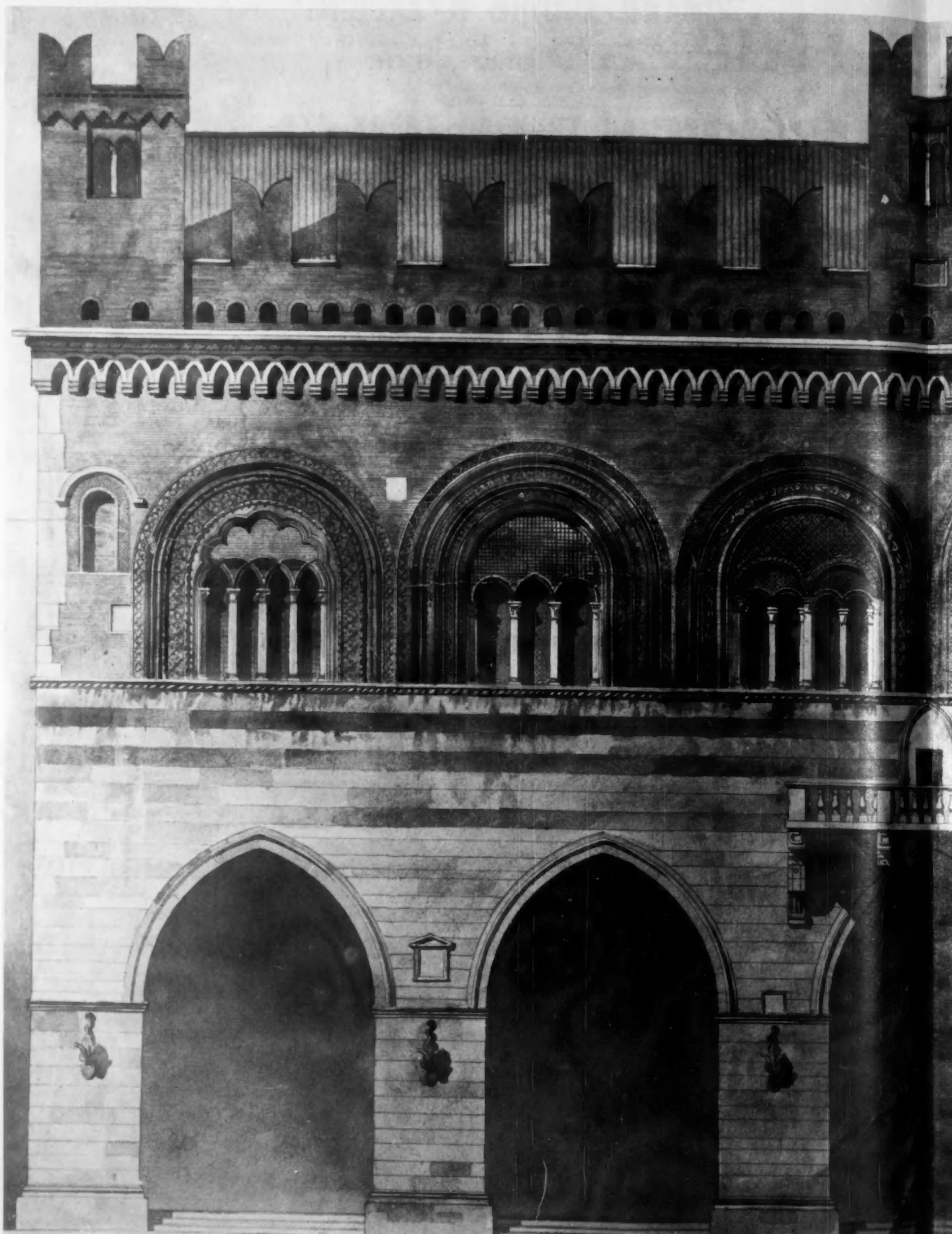
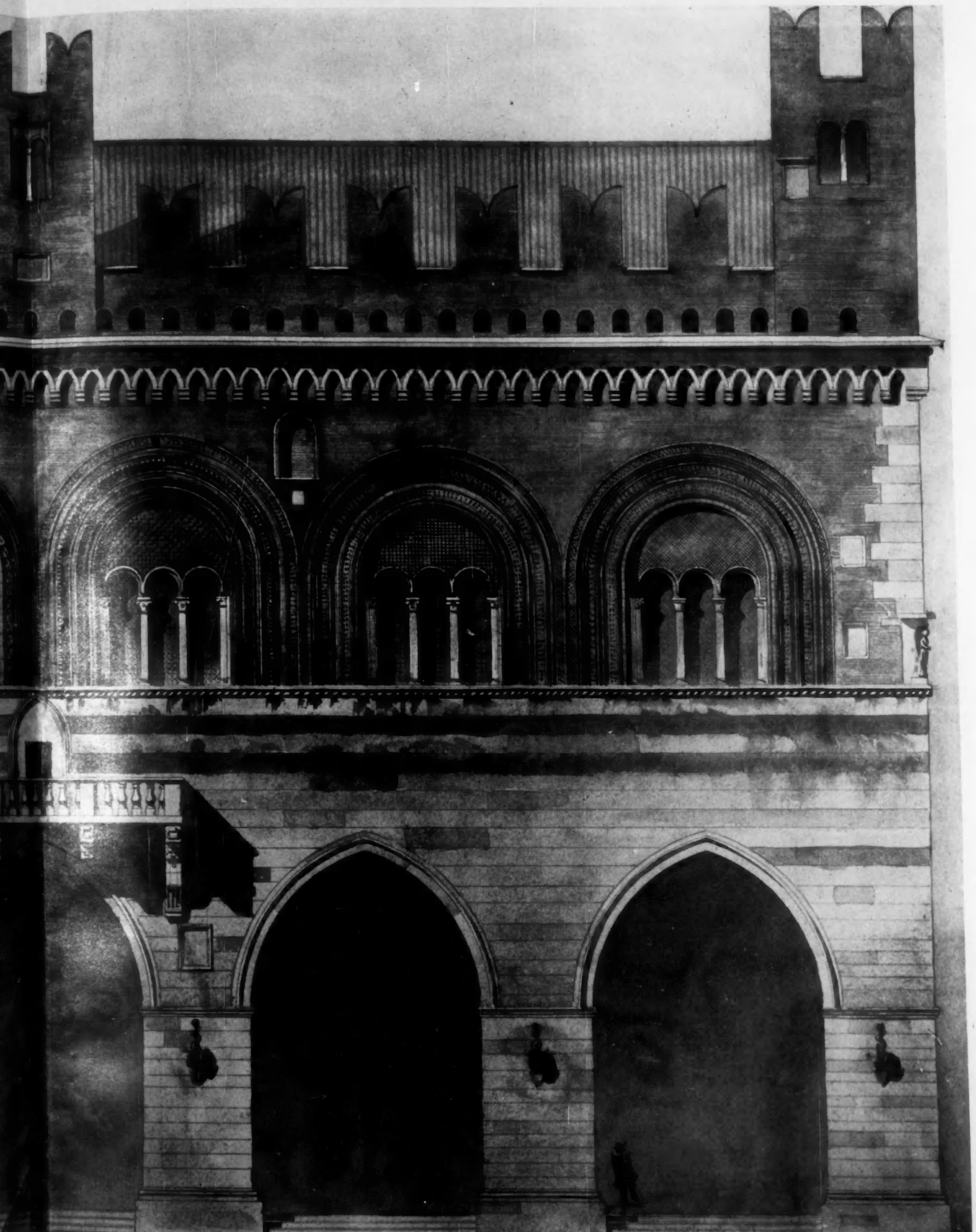
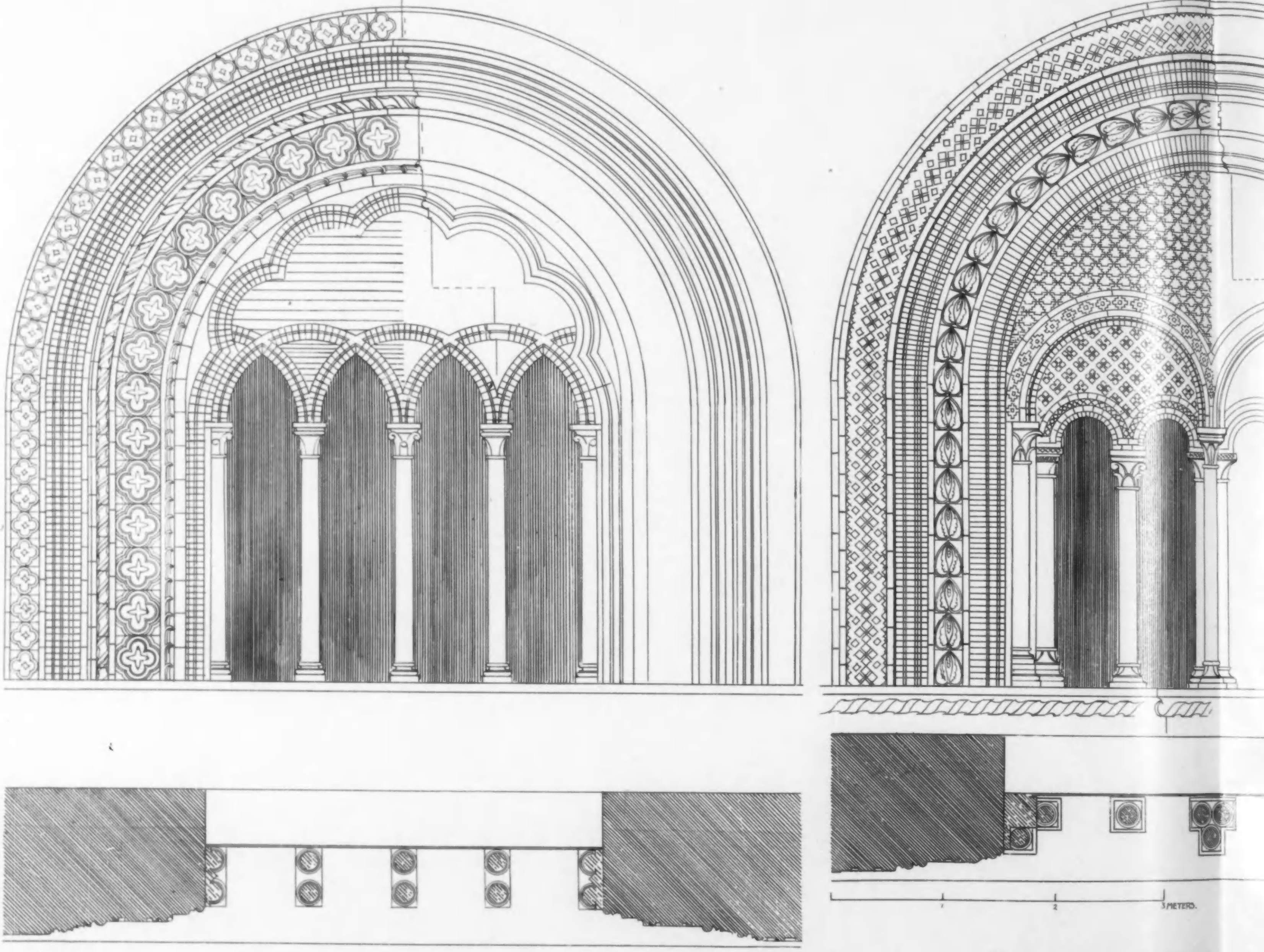


PALAZZO COMUNALE

MEASURED AND DRAWN BY GEORGE OAKLEY TOT

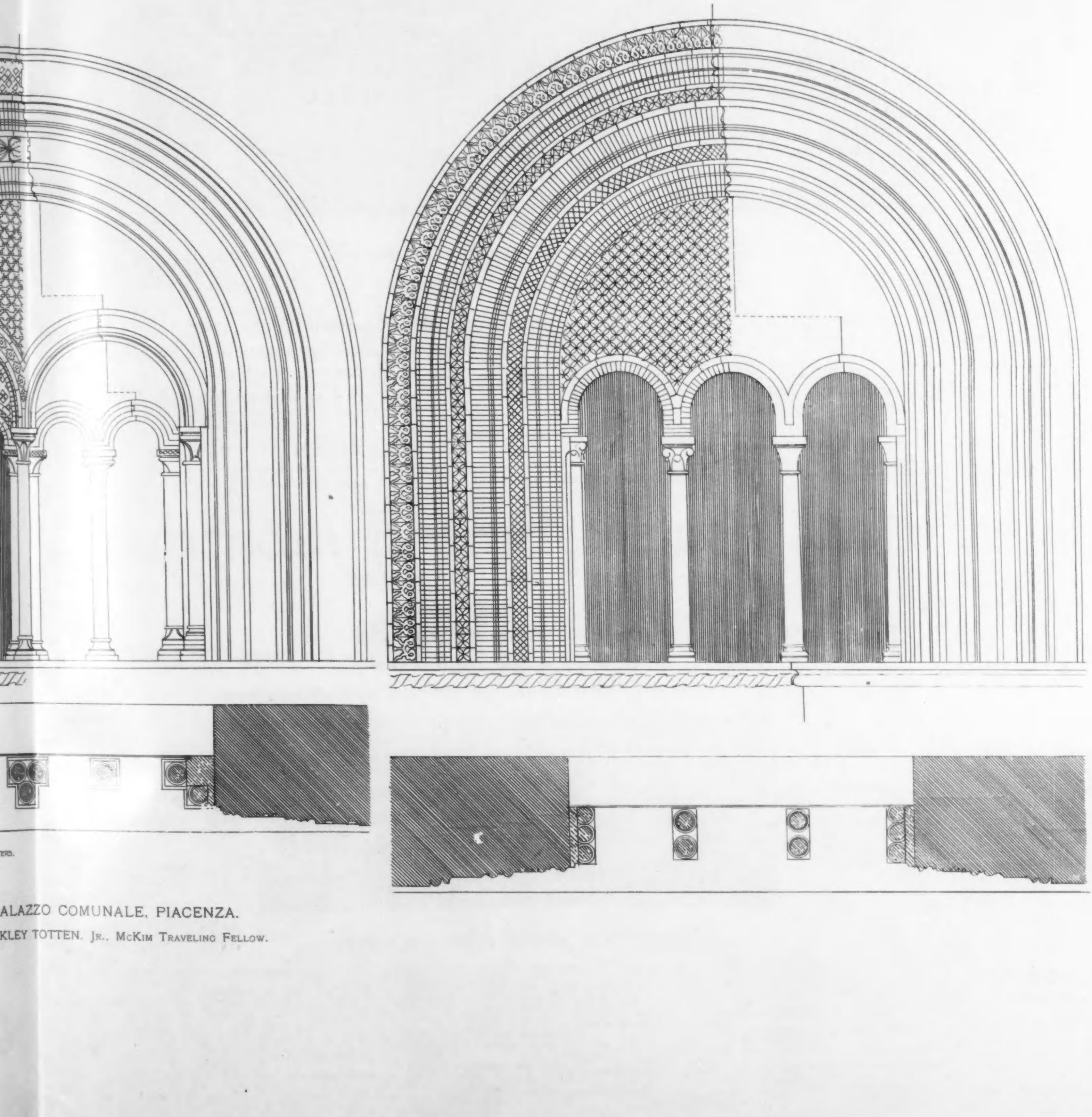


COMUNALE, PIACENZA.
OAKLEY TOTTEN, JR., McKIM TRAVELING FELLOW.



DETAIL OF WINDOWS, PALAZZO CO

MEASURED AND DRAWN BY GEORGE OAKLEY TOTTEN



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FINE PRESSED
FRONT BRICK
WHITE, OCHRE,
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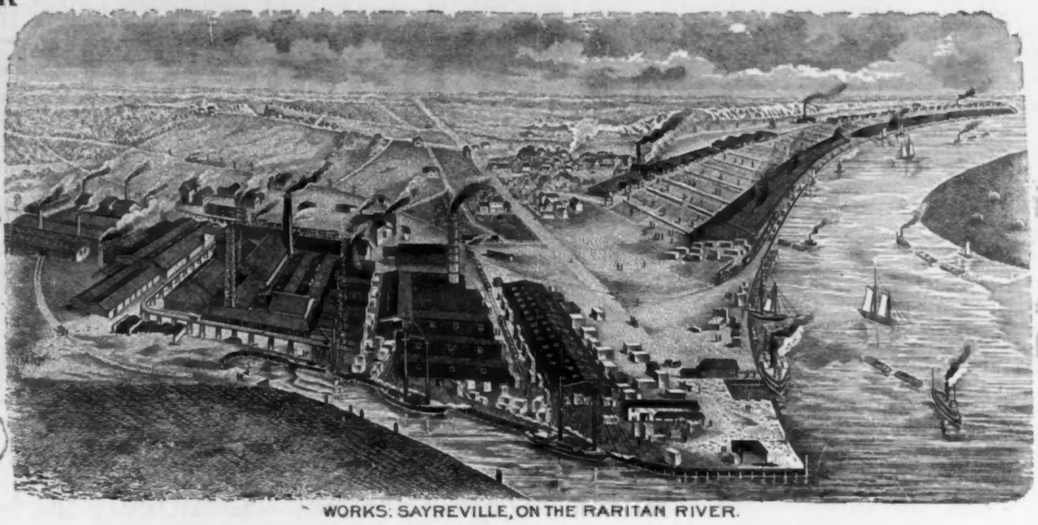
RED, GRAY, BROWN,
OLD GOLD, POMPEIIAN,
OR MOTTLED
PLAIN OR MOULDED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ALL SHAPES & COLORS.
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OF A SUPERIOR QUALITY,
All Shapes and Sizes.

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Our brick are all made after the Clay Tempered or Mud Brick Process and are recognized by our best architects, engineers, and contractors to be superior to any brick in the market. Our process of manufacture produces a brick very dense and hard, absorbing very little or no moisture, and a brick guaranteed to keep its color. They have been used in the most prominent buildings in New York City.

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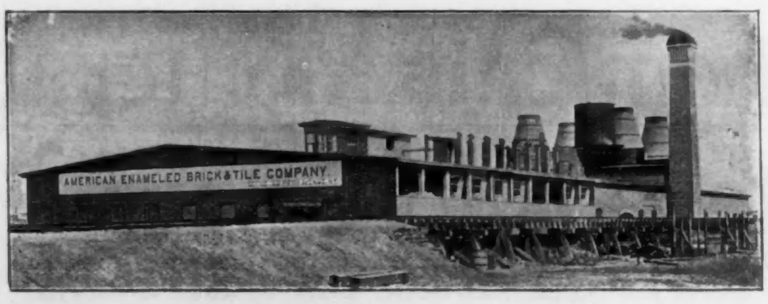

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Binghamton State Hospital, Binghamton, N. Y. Miles Leonard, builder.
St. Catherine's Hospital, Brooklyn, N. Y. Arch., Wm. Schickel & Co., New York. W. & T. Lamb, builders.
Bellevue Hospital, New York. Arch., Withers & Dickson. John F. Johnson, builder.
Brooklyn Distilling Co., Brooklyn, N. Y.
Mechanics National Bank, Brooklyn, N. Y. Arch., Johnson & Co. W. & T. Lamb, builders.
Trenton Water Works, Trenton, N. J. Arch., Wm. A. Poland. John Barlow, builder.
Mutual Life Building, Philadelphia, Pa. Arch., Philipp Roos. E. L. Pennock, builder.
Wadsworth Building, New York City. Arch., Youngs, Bergersen & Cornell. Robinson & Wallace, builders.
The Bowling Green Building, New York City. Arch., W. & G. Audsley. Standard Structural Co., builders.
Schenectady Water Works, Schenectady, N. Y. John McEnerge, builder.
Stamford, Conn., Railroad Depot (N. Y., N. H. & H. R. R.), Wm. A. Thomas, builder.
Hotel Manhattan, 42d St., New York City. Arch., Henry Hardenburg. Marc Eidlitz & Son, builders.
Brooklyn Trolley Power House, Chas. Hart, builder.
Altman's Dry Goods Establishment, 18th St., New York City. Arch., Kimball & Thompson. Chas. Sooysmith & Co., Marc Eidlitz & Son, builders.
Waldorf Hotel Extension, New York City. Arch., Henry J. Hardenburg. Chas. Downey, builder.
Private Stable, 120 East 75th St., New York City. John J. Tucker, builder. (These were made to match Farnley imported Brick, in white and in colors. Made in our new one-fire process and were pronounced by the owner a great success.)
Private Stable, Utica, N. Y. R. T. Proctor, owner. Arch., J. Constable. John F. Hughes, builder.
Addition to same Stable. Arch., R. M. Hunt, Jr., and Maurice Fournachon. John F. Hughes, builder.
Old Men's Home, Brooklyn (patent tile). Arch., Johnson & Co. Thomas Dobbin, builder.
Large Delicatessen Establishment and Restaurant, Harlem, N. Y. Arch., J. P. Walthers. Scheidecker & Gonder, builders.
Trolley Power House, Woodside, L. I. John D. Woodruff, builder.
Private Stable, Portchester, N. Y. Arch., Nathan C. Mellen. Wm. Ryan, builder.
Fire Engine House, Newark, N. J. James Moran, builder.
In addition to these there are other large contracts and an innumerable amount of smaller ones.
New York Athletic Club House, New York City.
Columbia College Gymnasium and University Hall, New York City. McKim, Mead & White, Architects. Norcross Bros., Builders.

THE HARBISON & WALKER CO.

Pompeian Brick.

Made by Mud Process, Hand Pressed, Fire Flashed. **OLD GOLD AND CHOCOLATE-BROWN COLORS.**

"POMPEIAN" brick made by this Company surpass all others in keeping bright and clean in Pittsburgh or any other atmosphere, as the following extracts from letters received will show:

PITTSBURGH, May 9, 1896.

. . . Ten years ago I built a residence here, using your "POMPEIAN" brick. These brick are to-day as bright and clean as when laid. They are impervious to water, and a driving rain clears the wall from dust and soot, instead of soaking the dirt into them, as it will with porous material.

PITTSBURGH, Jan. 14, 1896.

It is five years since my house was completed. So far as can be seen, the brickwork is as clean as on the day the building was finished.

CLEVELAND, O.

Your "POMPEIAN" brick stands the Cleveland climate better than any other brick I have observed, retaining their bright, clear appearance.

BUFFALO, N. Y.

The brick to-day look brighter, cleaner, and more attractive than they did when the building was first erected, and every rain storm seems to freshen them.

Send for descriptive pamphlet showing photographs of buildings and mantels in which our brick have been used.

RESIDENCE OF JAMES G. PONTEFRACT, ALLEGHENY, PA.
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A Superior Brick

For Exterior and Interior Facing, Mantels, Floors, etc., in any size, shape, or color desired, is

The Shawnee Brick,

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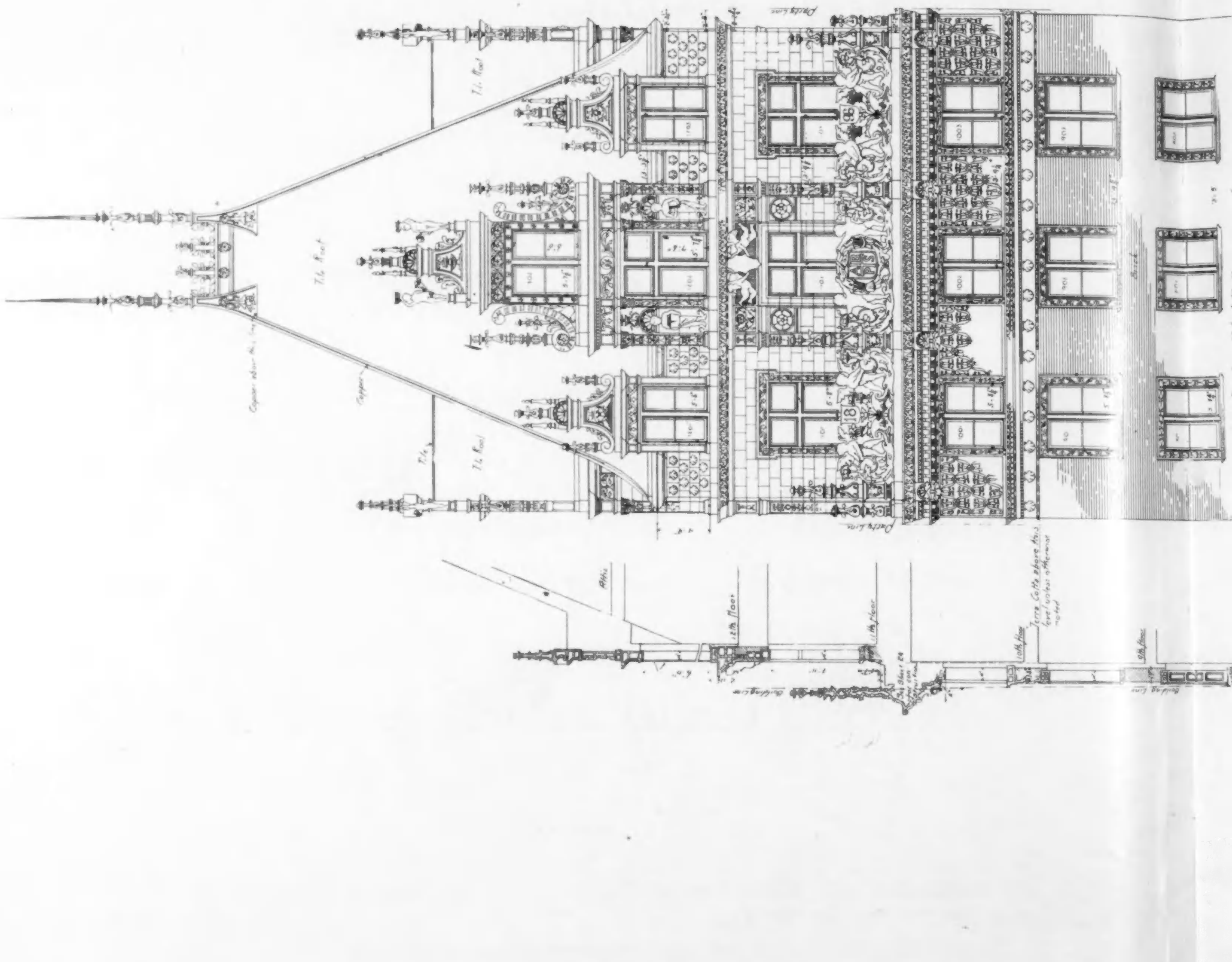
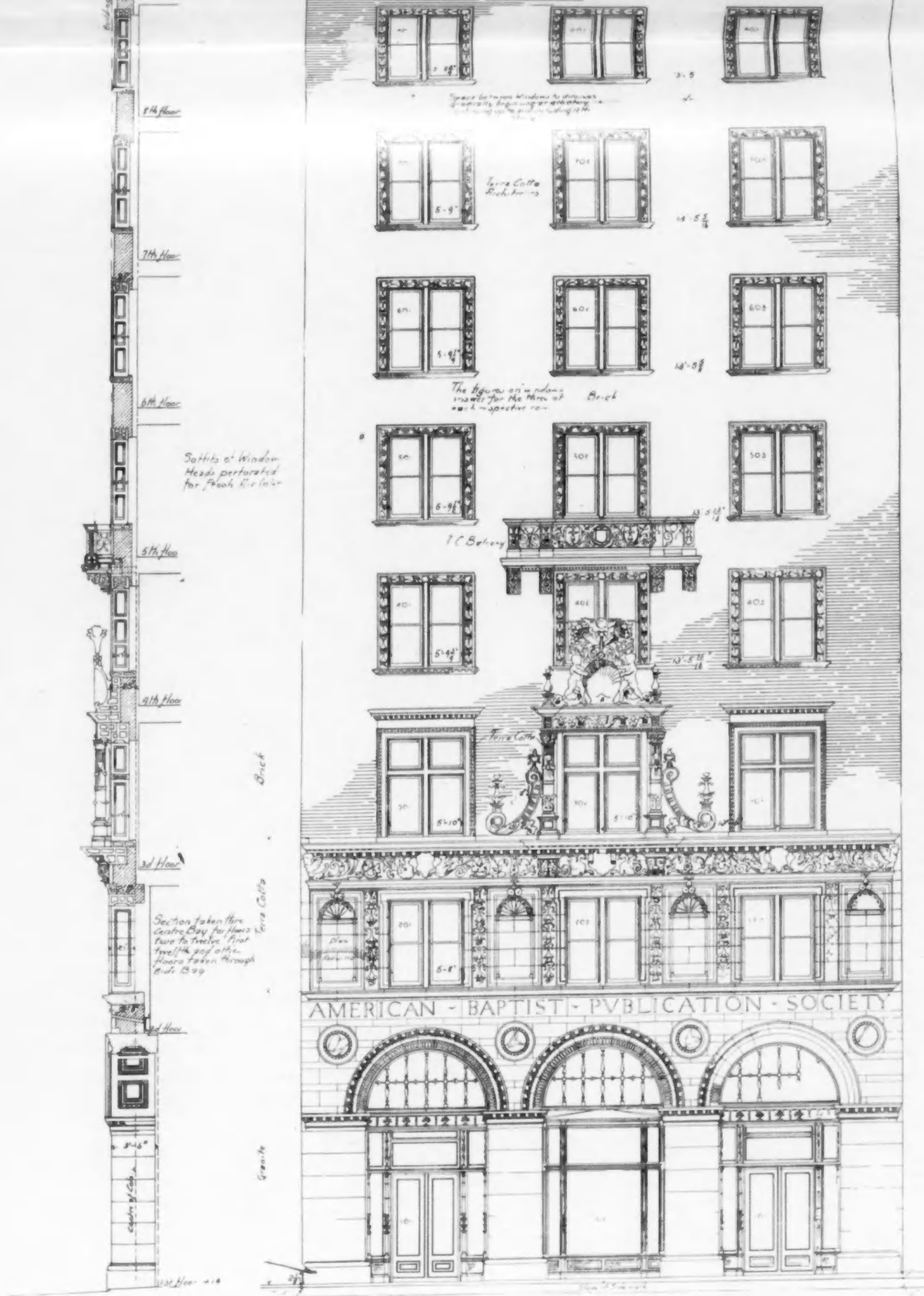
These brick can be seen and purchased at the following places:

NEW YORK, The Powhatan Clay Mfg. Co., 1121 Broadway. **BUFFALO**, Brush Bros., 2 Builders' Exchange.
CINCINNATI, Mendenhall & Neff, 237 West Fourth St. **INDIANAPOLIS**, Consolidated Coal & Lime Co., 13 Virginia Ave.
CHICAGO, Geo. B. Engle, Jr., 808 Chamber of Commerce.





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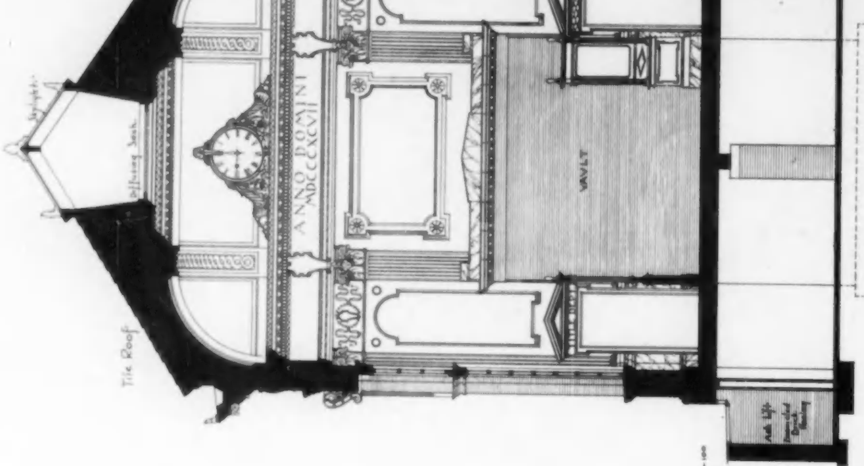

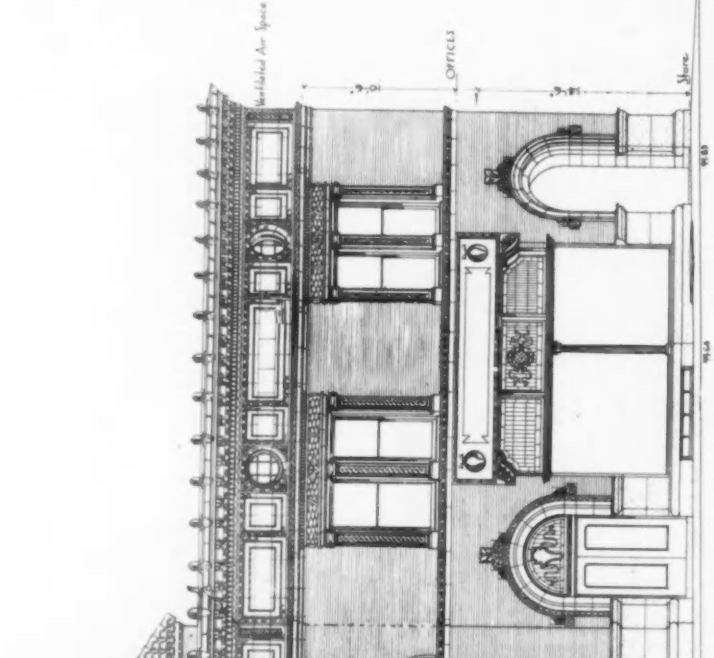

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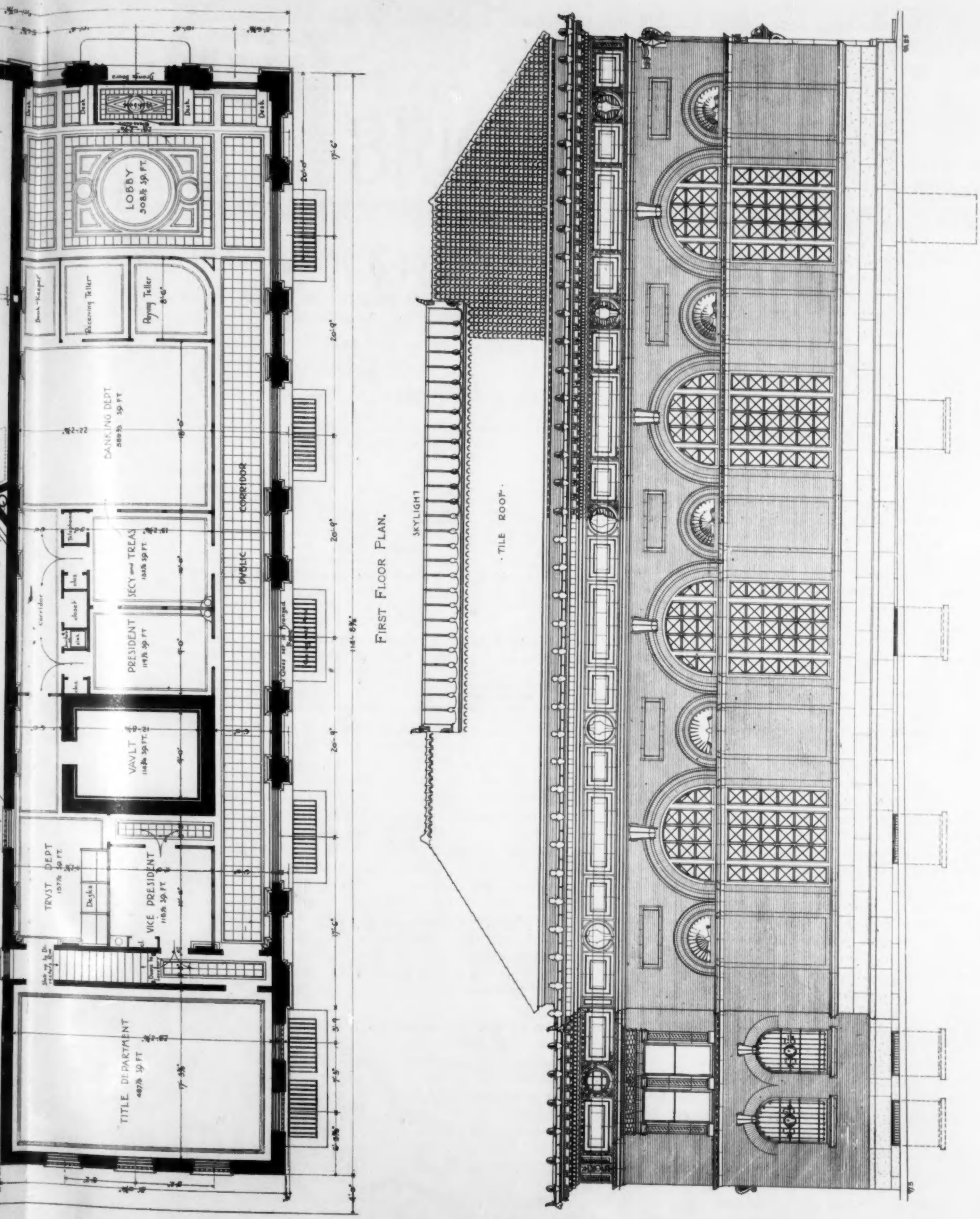

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